POWER PLANT ENGINEERING

Trade-mark reg. U. S. Pat. Office

VOL. XXIV CHICAGO, NOVEMBER 15, 1920 No. 22

Refrigerating Plant at Los Angeles Wholesale Terminal

REFRIGERATING PLANT IS AN ESSENTIAL PART OF LARGE WHOLESALE TERMINAL FOR HANDLING PRODUCE. BY C. W. GEIGER

THE WHOLESALE HANDLING of produce for a large city is at its best an intricate problem and unless adequate facilities are provided, the process will suffer from inefficiency. As regards facilities in this respect, the city of Los Angeles is well provided for their Wholesale Terminal possesses means for doing business which are unequaled by any city in the country.

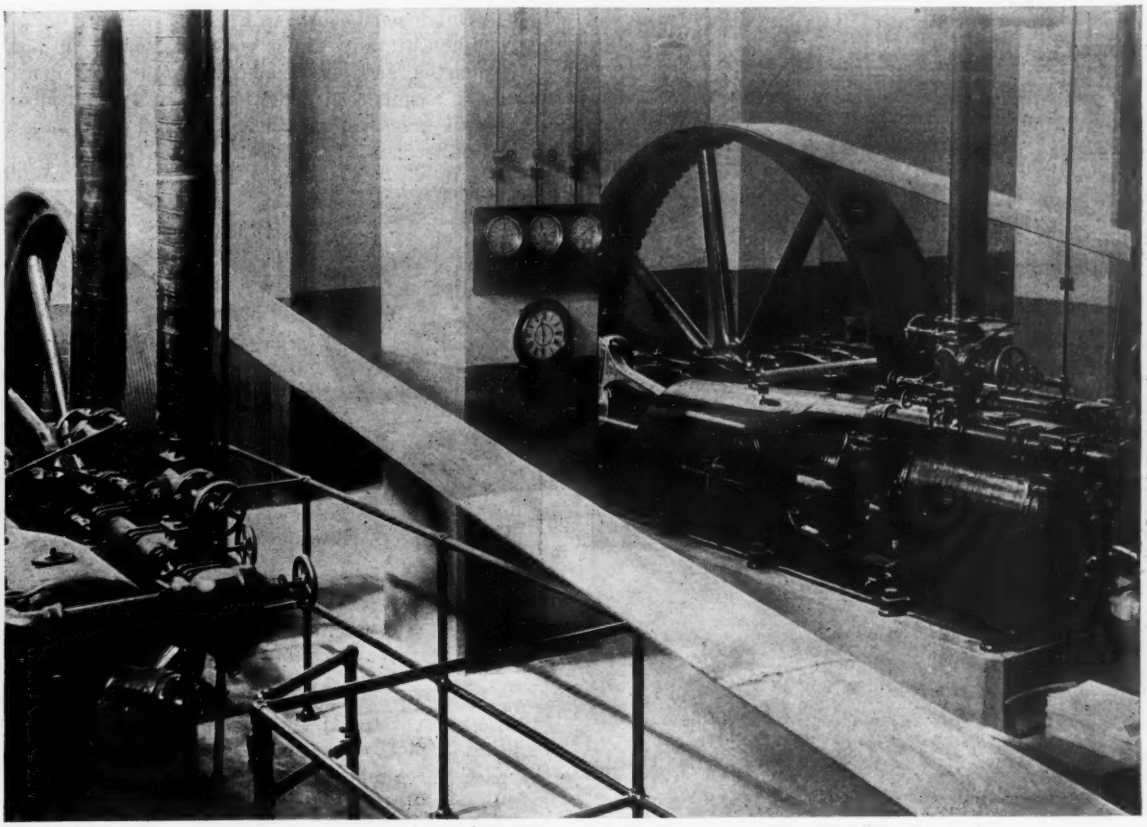


FIG. 1. VIEW OF ENGINE ROOM OF REFRIGERATING PLANT

This terminal consists of seven large buildings together with ample space for docking and marketing purposes. The market system was planned and constructed for the sole purpose of providing a place where the produce business of Los Angeles could be conducted on the most efficient and economical basis possible. The various buildings that comprise the terminal are shown in Fig. 2. Large wholesale and manufacturing concerns occupy four of the six-story buildings while the buildings marked B, B are occupied by fruit and produce dealers who deal mostly in carload shipments. These concerns buy fruit and vegetables from the growers, and ship out in straight and mixed car loads. The long building shown at C is occupied by dealers who buy from growers and sell to the retail grocers and cartmen. There

is a five-acre yard which occupies the space between the market buildings which is divided off into 600 stalls for the farmers and growers. The farmers deliver their fruit and vegetables to the market yard in motor trucks, and are ready for business at the opening of the market at 4 o'clock in the morning.

Refrigerating Plant

The Terminal Refrigerating Company's plant occupies the building indicated at A, and in addition to furnishing refrigeration to its own storage rooms, supplies brine to those dealers in the market buildings having cold storage equipment for handling fruit and produce.

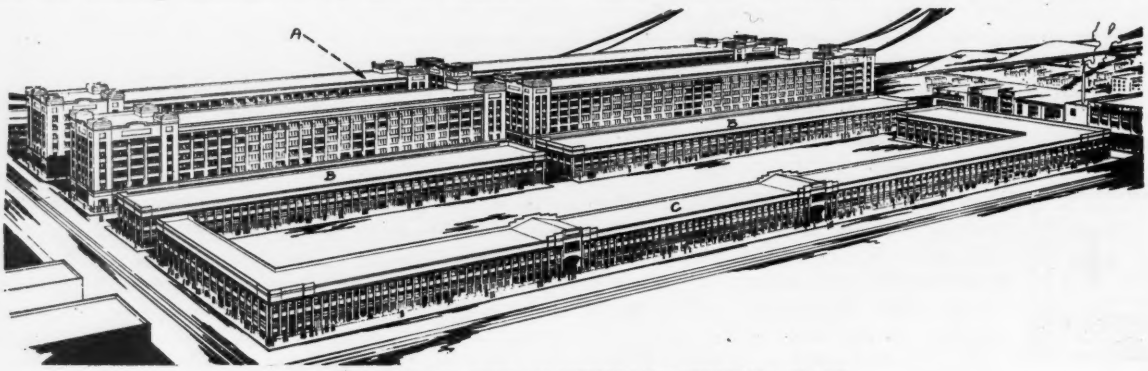


FIG. 2. GENERAL VIEW OF WHOLESALE TERMINAL PLANT

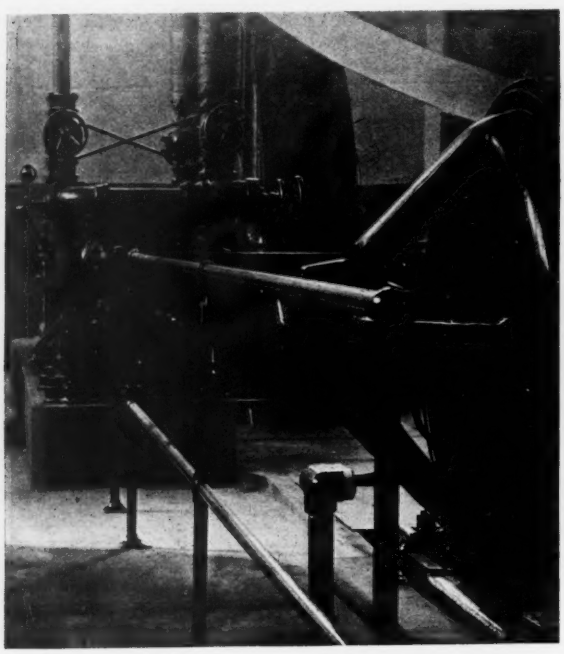


FIG. 3. SHOWING GUARD RAILS AND STEEL FLOOR PLATES

The engine room although located in the basement is well lighted by means of windows near the ceiling during the day while at night illumination is secured by tungsten lamps suspended from the ceiling and fitted with metal reflectors. The refrigerating machinery throughout is operated by electric motors, a total of 340 hp. of electric motors operating 175 tons of refrigerating machinery. The electrical installations vary in size and range from about 10 to 150 hp.

Safety Measures

Modern safety devices, recommended by the state are fitted wherever possible. All moving apparatus, such as flywheels, belts, electric motors, etc., are enclosed within iron pipe railings, fitted with gates which close automatically. Passageways between belts are likewise bannistered and a steel plate bridged over the lower run of belts serves as a walk. This arrangement is shown in Figs. 1 and 3.

The switchboard shown in Fig. 4 is specially designed for the class of work under consideration. The panels are of marble, and are fitted with both hand operated and remote control switches for operating circulating pumps, air compressors, air circulating fans and ammonia compressors.

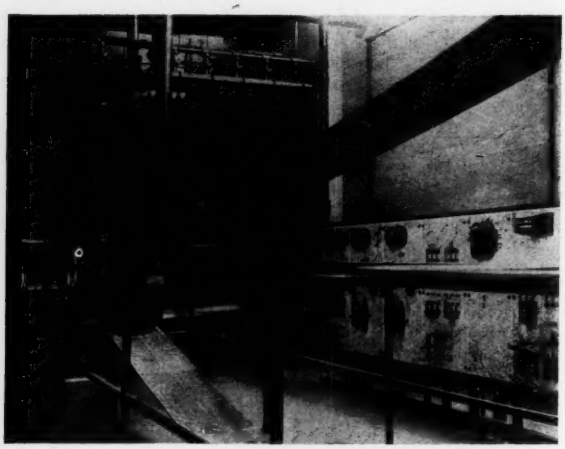


FIG. 4. PARTIAL VIEW OF AMMONIA CONDENSER AND SWITCHBOARD

The refrigerating plant occupies half of the six-story building. On the first floor are located the office and the general cooling room. The second floor is occupied by the freezing room, designed for a temperature of 20 deg. below zero. The third, fourth, fifth and sixth floors are designed for egg and apple storage with temperatures as low as 10 deg. F.

Over 22,400 ft. of 1¼-in. brine circulating pipe serve to maintain the desired temperatures in the cold storage section alone. Cooling is effected by 5800 lineal feet of

2-in. ammonia coils. The 40 refrigerating compartments range in size from 40 by 40 to 60 by 100 ft. All walls are of concrete and hollow tile construction, with 5-in. cork board on all outside exposed walls, and 3 in. of cork on all partitions. The floors are of concrete 4 in. thick, 4 in. of cork and an average of 10 in. of tile, then 3 in. of cork and plaster which forms the ceiling for the compartment below.

Method of Running Piping

All the leading pipes throughout the building run from the basement to the roof through an especially designed pipe shaft shown in Fig. 5. This shaft is 10 ft. wide and 3 ft. across and runs parallel with the stairways having an opening at each landing, making it very convenient to reach for the purpose of repairing or for installing new pipe.

There are 10 sections of double pipe ammonia condensers 22 ft. long, 3 in. in diameter. These are located in the basement as shown in Fig. 4. With the system of counter balanced water there is no need of having this on the roof. The cooling tower is mounted on a concrete base built directly on the concrete roof and together with other water equipment has a capacity of 8000 gal. per min.

The ammonia receiving tank is 18 ft. long and 36 in. in diameter. All pipe hangers and supports were installed in the soft concrete when the building was in course of construction. The hangers consist of ⅝-in. rods with a lateral system of pipe supports. The upper pipe hanger is supported by spacer pipes which are not only neat but substantial.

There are three elevators with a capacity of 5000 lb. each designed for a speed of 100 ft. per min. and with telecable control connected with vestibules to all rooms. Automatic cutouts for overload, high and low loose cable, automatic switches, etc., eliminate practically all danger of accidents.

For the receiving and delivering section, there are 480 ft. of docks extending on both sides of the building, and 440 ft. of switches capable of accommodating eight cars. The shipping side can accommodate 20 motor trucks.

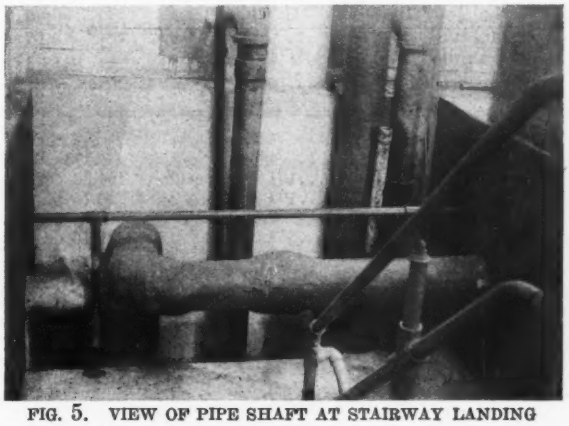


FIG. 5. VIEW OF PIPE SHAFT AT STAIRWAY LANDING

The market buildings B, B, and C, have a total length of over 2800 ft. and it is in these buildings that the producer, shipper, wholesaler and retailer in fruit and vegetables meet to transact their business. These buildings are connected with the refrigerating plant, from which brine for cooling purposes is furnished.

The whole plant, as was stated before, was designed for the one purpose of facilitating the handling of produce, and the completeness with which this purpose is attained speaks well for those who were instrumental in its achievement.

Soot Deposits in Oil-Fired Boilers

Description of Tests Indicating the Advisability of Equipping Oil-Fired Boilers with Soot Blowers. By Robert June

THE soot deposit resulting from the combustion of oil is in the nature of a pure carbon mixed with a slight amount of oil. It is somewhat fluffy in appearance and adheres readily to the tubes, but is easily cleaned and removed from the boiler under the operation of a steam jet. It is entirely different in character from the soot resulting from combustion of coal on account of the absence of ash, etc., and the presence of greater or less quantities of unburned oil, which going through the boiler tend to deposit on the tubes in combination with the soot. If this formation is not removed at regular frequent intervals, it soon crystallizes or carbonizes on the tubes and must then be scraped off with rods or bars.

Soot deposits from oil-fired furnaces have a much greater insulating effect than those occurring with coal-fired furnaces. There are two reasons for this: First of all, the deposit is in the nature of a pure carbon which has greater insulating properties than various ash constituents found in soot from coal; second, the deposit being of a somewhat fluffy adhesive nature, is usually found to envelop the entire tube as compared with coal deposit which usually consists of soot, dust and ashes building on top of the tube and leaving the underside more or less clean.

For some time after oil came into use for boiler furnaces, the impression prevailed that oil-fired boilers did not require as frequent or as thorough cleaning as coal fired. The efficiencies of oil-fired boilers were generally higher than those obtained where coal was used as fuel, due to more perfect combustion with a smaller quantity of excess air, and this improvement was for some time accepted on its face value as the best obtainable. With the increasing use of oil as fuel in the past few years, it was inevitable that detailed tests should be inaugurated of the performance of oil-fired boilers with and without mechanical soot blowers.

These tests developed the fact that mechanical soot blowers are absolutely essential to the development of the highest efficiencies on oil-fired boilers.

As an example, attention is called to the results of the following test by the Pacific Gas and Electric Co.

TEST DATA BEFORE USING SOOT BLOWER

Time A. M.	Stack	Temperature Sup. Steam	Load Meter
10:15	550	500	4.2
10:30	550	502	4.0
10:45	555	498	4.0
11:00	557	498	4.1

TEST DATA AFTER USING SOOT BLOWER

Time A. M.	Stack	Temperature Sup. Steam	Load Meter
2:30	485	495	4.2
2:45	485	506	4.0
3:00	482	504	4.3
3:15	483	505	4.2

Test Results—	Before	After
Load meter	4.075	4.175
Per cent rating	101.88 per cent	104.38 per cent
Steam pressure gage	199.5 lb.	200.75 lb.
Superheated steam temperatures	499.5 deg. F.	502.5 deg. F.
Stack temperature	553 deg. F.	483.75 deg. F.

"These results show that the soot blowing caused the temperature of the stack gases to fall from 553 deg. F. to 483.75 deg. F., making a difference of 69.25 deg. F. or 13.05 per cent.

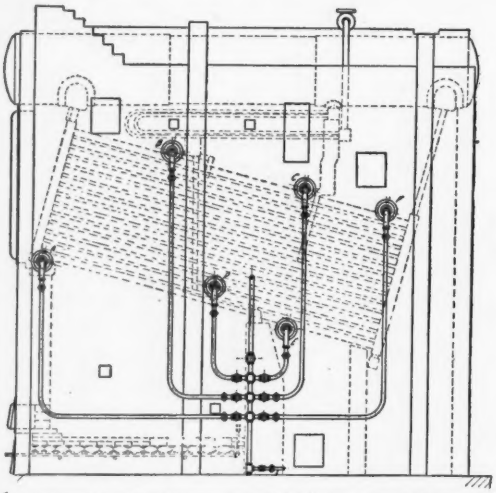


FIG. 1. TYPICAL OIL-FIRED INSTALLATION SHOWING LOCATION OF SOOT-BLOWING UNITS

"Also the temperature of the superheated steam was raised from 499.5 deg. F. to 502.5 deg. F., a raise of 3 deg., or 0.6 per cent.

"The direct effect of the use of mechanical soot blowers is a saving in fuel of 3.9 per cent."

The Texas Co., Port Arthur, Texas, found a saving of 5.5 per cent fuel by the use of mechanical soot blowers and as a result ordered mechanical soot-blowing equipment for 30 oil-fired boilers. As this company is in the oil producing business, its action is particularly illuminating.

These tests were followed by others at some of the large Western central stations. On one of these, the boiler, a large vertical water tube, was taken off the line, and the tubes, superheater, etc., washed clean. The boiler was then fired up and an evaporation rate of 37,000 lb. of water per hour and 14 per cent CO_2 was maintained. At the end of 24 hr. the soot blowers were operated, and were used for 24-hr. periods for the remainder of the test with the equipment. During these tests readings were taken at 15-min. intervals of the water-rate, CO_2 draft, oil and superheat. When using the blowers, the flue temperature dropped to 525 deg. and rose to 540 deg. in about 15 min. It ranged around 540 deg. for about 16 hr., and then gradually crept up to 590 deg. at the blowing period, when it again dropped to 525 deg. This was the regular daily performance throughout the test while using the blowers.

At the end of a seven-day period the boiler was given a final blowing and thereafter operated under the usual plant conditions; i. e., without any cleaning at all. At the end of the first 24-hr. run, the temperature had risen to 590 deg., at the end of the week it had risen to 680 deg., and at the end of 10 days had risen to 720 deg., at which point it seemed to hold. But they were not

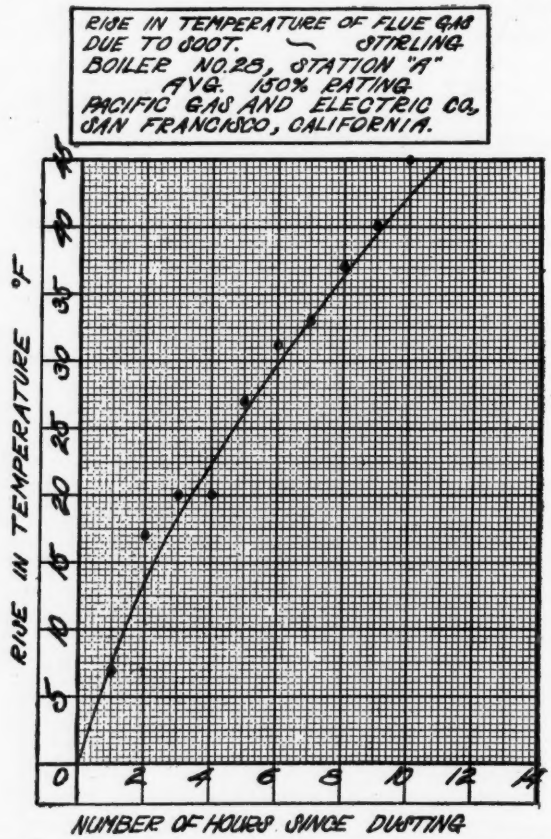


FIG. 2. RISE IN FLUE GAS TEMPERATURES DUE TO PRESENCE OF SOOT IN OIL-FIRED BOILERS

able to maintain the evaporation rate, which dropped to 34,000 lb. per hour. The saving effected by mechanical soot blowers amounted to 6 per cent.

Despite the war emergency, with its constant urge to speed, rather than to thoroughness, the Emergency Fleet Corporation made some very detailed tests of mechanical soot blowers before adopting them. These tests were conducted at Burlington, Iowa, under the direction of the Bureau of Mines.

The boiler selected was of the marine water-tube type, and was one of a large number then being built at Burlington, Iowa, for delivery to the Emergency Fleet Corporation. The tests extended over a period of a number of weeks, and covered a wide variety of operat-

ing conditions, with boilers forced to high rating at times, with different conditions and drafts.

In addition to proving the necessity of soot blowers to economical operation, the tests threw some important light on soot-blower construction. For instance, in boilers burning fuel oil draft conditions are very low, running from 0.02 in. in the furnace up to 0.08 in. in the uptake. If soot blowers were so designed that all nozzles emitted steam at the same time, a curtain or blanket of steam would be ejected into the boiler at high velocity, with the result that it would either put out the fire or materially interfere with the draft. The bad effects of interfering with the draft can hardly be overstated. As a result of such a condition, all of the factors in the operation of the boiler become unbalanced. This applies to the feed of oil to the furnace, the maintenance of even steam pressure, and the injection of the feed water. In place of a normal even operation, a condition of ebb and flow takes place which may last for an hour or more before conditions again become normal. Necessarily, this entails additional work on the part of the fireman who finds the whole routine and operation of the boiler room upset.

In order to take account of this condition, the soot blower for hollow staybolt boilers is made up in vertical sections, each under the control of its individual valve. This arrangement permits of blowing three or four vertical rows of tubes at one time, thus avoiding all interference with the draft.

On stationary boilers of the horizontal water tube type, vertically baffled, and on vertical boilers, where revolving soot-blower units are commonly used, the use of oil for fuel calls for little change in construction. Care is taken in locating the units to be sure that they blow with the draft. In addition, it is sometimes found advisable to stagger or offset the blower nozzles so that they do not all blow in the same direction at the same time.

As a result of the Burlington tests, hundreds of oil-burning vessels built by the Emergency Fleet Corporation were equipped with mechanical soot blowers. In conclusion, the mechanical soot blower for oil-fired boilers is here to stay, and the use of blowers on such boilers is fast becoming as common as the use of blowers on coal-fired boilers.

Water Purification for Boiler Feed*

PROBLEMS TO BE SOLVED AND METHODS OF SOLUTION. BY F. J. CROLIUS

WHEREVER steam power is developed, the first consideration must be the water. Of the raw materials entering into the manufacture of steam, water is by far the most important. You can burn any kind of coal, from lignite to Pocahontas, bagasse, tar, oil, blast furnace gas or waste heat—that's merely a question of equipment and furnace construction—but you can't burn any of them efficiently without first guaranteeing your much abused enemy—the boiler—a sufficient supply of properly conditioned "feed."

Sources of supply are infinite, but can be classified under several major headings, in order of desirability:

1. Condensate.
2. Lakes or larger bodies of fresh water.
3. Flowing streams.
4. Wells.
5. City supply.

Condensate can be dismissed with a few words. It is the most desirable form of feed and all properly designed power houses are founded on the rock of condensate.

Next to condensate come large bodies of fresh water, your lakes, for instance. Such water has the merit of uniformity, and when a practical method of purification has once been developed, practice becomes a constant year in and year out performance and nothing more than attention to detail is necessary.

Flowing streams have a different aspect, being either acid, as the Monongahela River, or alkaline, as the Ohio or Mississippi or the Schuylkill in Philadelphia. They have one merit, however, though they may vary seasonally by rainfall influence, the mere fact that they flow reduces the daily average to a set of curves which their dilution maintains normal. Concretely the Monongahela—a free sulphuric acid river—fluctuates hourly over a range of acid from 10 to 200 parts per million. But a series of analyses covering the entire range of acids develops a corresponding set of curves for the calcium, magnesium, chlorine, sulphates, etc., over the whole range. Once this fact was established, the solution was simple, and the laws hold good along the entire length of river. What seemed a very baffling and expensive mystery is now an open book.

Wells are next to the last resort, due to drilling and pumping costs, and are usually the poorest source of supply. The general characteristics of a well supply would be a concentration of the elements found in the flowing streams adjacent. While the water would be more constantly uniform in its analysis, the lime, magnesium and chlorine would be so much higher in content that the problem would be complicated. Wells, however, are entirely a local problem, and could not be discussed in general; each requires its own special investigation.

City supply is frequently resorted to because the water is known to be "pure," usually filtered and looks harmless. No greater fallacy could exist. City water may be "pure" for stomachs and kidneys, but boilers are not equipped with those valuable organs. The water was probably prepared for domestic and sanitary purposes, germs killed with chlorides, filtered for organics, etc., but none of the scale forming solids have been touched. The cost of this treatment—entirely unnecessary for boiler use—must be added to your treatment cost which must be resorted to in addition, and your total cost of good water is thus correspondingly higher. Only in isolated cases is it necessary to resort to city water.

* From a paper read before the Detroit Engineering Society.

Character of Various Waters

Irrespective of the varying proportion of the contained elements, raw waters are acid or alkaline, bi-carbonate or carbonate, and where water is acid it can be carried over to the alkaline by neutralization, reducing the subject to the single research into the unstable relation of bi-carbonate to carbonate.

Most waters used in the industrial areas in this country are bi-carbonate and until the acid radical is eliminated, no stable results are possible. Any chemist will tell you that in the presence of carbonic acid, which is a resultant of temperature and boiler pressure applied to bi-carbonates, the reducing value of soda ash is destroyed.

Any chemist will tell you that the addition of excess calcium hydrate will destroy the value of soda ash as the soda ash is converted into caustic soda, which is inactive as a reducing agent where calcium sulphate is present.

In other words, we must start any treatment by the definite elimination of all bi-carbonates. When that has been accomplished we have found the key to Pandora's box of mystery, for our internal reactions are stable and our laboratory checks with our practice. At this point, let us examine the mineral, the salts and the acids and inquire into the various elements which cause trouble or may be rendered harmless.

We hear much of hardness, both negative, temporary and permanent; and we wonder whether hardness means scale formation or corrosion, or both; as a matter of fact, it means nothing unless understood in its proper relation.

They may be set down in the following category:

Free CO_2—which is corrosive } are negative hardness,
$NaHCO_2$—which is not corrosive } but not scaling

$CaH_2(CO_3)_2$
$MgH_2(CO_3)_2$ } are temporary hardness, but non-scaling
$FeH_2(CO_3)_2$

$CaSO_4$ } non-corrosive, are permanent hardness and scale
$MgSO_4$ } forming

$FeSO_4$
$Fe_2(SO_4)_3$
$Al_2(SO_4)_2$ } all corrosive, are permanent hardness and
$CuSO_4$ } scale forming except H_2SO_4
H_2SO_4

These combinations are all our enemies and, in addition to chlorine, cause most of our trouble. Chlorine plays a part by itself and must be isolated to be rendered harmless.

From the foregoing table it can be plainly seen that the troublesome hardness known as permanent hardness falls entirely within the sulphate range and investigation will show that most efforts are and must be directed toward reduction of sulphate.

$CaSO_4$—$MgSO_4$ are the principal scale-forming offenders, but as neither are corrosive, the simplest procedure is to convert them to $NaSO_4$ (and Ca or Mg carbonates, which are insolubles) by the addition of sodium; they are then solubles and harmless. The usual percentage of iron, aluminum and copper sulphates is so low that in the case of most commercially used waters they can be ignored. This is fortunate, as their removal or conversion is not always a simple matter and frequently requires expensive individual treatment.

At this point, let us examine a number of actual water analyses and compare them.

There are various ways of reporting complete analyses of water; but for all practical purposes, a report giving the following elements will be entirely adequate, expressed either in parts per million or in grains per gallon, parts per million being preferable. The following are in part per million:

	Total Solids	CaO	MgO	SO_3	Cl	Acid	Alkalinity
(1) A good alkaline lake water	200	102	44	38	16	..	120
(2) Bad acid river water....	684	118	47	386	27	92	...
(3) Same (No. 2) water neutralized with Na_2CO_3	804	117	46	398	26	..	18
(4) Same (No. 3) water after 10 days' accumulation in boiler	12,210	123	368	6278	810	2	...
(5) Same (No. 3) water properly treated 10 days' accumulation in boiler	2,188	0	0	564	180	..	466

What do we note?

First—All contain the same chemical elements, but in different proportion, except that samples Nos. 1 and 4 are acid, while samples Nos. 1, 3 and 5 are alkaline to varying degrees.

Second—No. 2 sample, being feed water and acid, must be neutralized. (In this case Na_2CO_3 was used.)

Third—No. 4 sample, being internal boiler water, should have been alkaline, but is acid, therefore corrosive, indicates imperfect treatment requiring further investigation.

Fourth—Concentration of mineral salts has occurred heavily in chlorine and magnesium.

Stopping to reflect upon these phenomena, we recognize that as the point from which most chemical treatment starts and to save you all the several thousand analyses that we made, I'll record the fact that the answer is secondary reactions within the boiler under the influence of temperature and pressure, these caused mainly by the failure to understand what bi-carbonates are, what bi-carbonates do and why bi-carbonates are a source of unseen difficulties. This has been mentioned before, but is worth repeating; bi-carbonates under the influence of pressure and temperature break off CO_2, which is strongly corrosive, and the reducing value of soda ash is largely destroyed.

It is not necessary to tell you now how to eliminate bi-carbonate—any chemist knows—and the particular reagent used with the method of its use will depend largely upon the given plant condition and equipment.

We held before us as an index of the proper method of boiler water purification a set of qualifications up to which the ideal should measure:

1. Any character of water should be handled successfully.

2. Using any character of water, the resultant should be a water which maintained an internal boiler condition of a pre-determined alkalinity, without bi-carbonate, without scale formation, without corrosion, without foaming.

3. Which resulted in no formation within the feed lines and pumps, and no undue deterioration of either.

4. Which caused no deleterious effects in the carried over steam to prime movers, packings, lubrication or the product.

5. Which required a minimum of expert attention, and was least likely to fail account of personal element.

6. Which involved only simple standard mechanical elements in a new installation or none or slight changes in existing equipment in old installations.

7. Which permit the use of only standard reagents.

8. And standard indicators.

9. Require no filters.

10. Which was unlimited in capacity.

11. In which the installation cost was low, compared with results—and the operation cost normal to the character of the water supply.

12. Which eliminated boiler repairs under maximum forcing.

We proceeded to classify various types equipment:

1. Permutit, a mechanical method of applying a remarkable chemical phenomenon. Not new, having been used in China 2000 yr. ago, more recently modernized by a German named Gans, then expanded and improved in America.

Briefly, permutit is a zeolite, possessing the peculiar characteristics of change of base. The material, a synthetic sodium-aluminum-silicate, is arranged in filters so that the flow of water through can be reversed quickly and frequently.

A water containing lime and magnesiums—that is, our ordinary alkaline feed supply containing scale forming hardness—is run through this sodium filter and the calcium-magnesium bases exchange with the sodium of the zeolite, and the filter bed is now calcium-aluminum-silicate, which must be regenerated with sodium before being useful again. This regeneration is done with a solution of ordinary sodium-chloride. The operation is nearly automatic and the reaction and results as perfect as could be desired; but permutit costs money, real money, to install and also has its drawbacks for boiler feed.

Where water is acid, it must first be neutralized.

Where water is turbid, it must first be filtered.

Where the water is strongly bi-carbonate, it must first be rendered carbonate, as the zeolite in no way affects CO_2.

2. Lime and soda plants, intermittent or continuous, with or without filters, vary but little, except in some particular type of control which each manufacturer has developed to make his installation attractive. Some engineers prefer the continuous type, owing to the greater capacity per dollar invested, while the more conservative adhere to the intermittent tankage, owing to its inherent insurance against mistakes in chemical proportioning and changes in raw supply.

All are good, however, in that they do furnish an approximate measure of water to be treated and definite precipitation period for reactions to occur; at least, they are supposed to do this, but frequently are so badly overworked that the average intermittent system becomes almost continuous. All are bad, however, unless the same care and study are applied to their operation that would be applied without them.

3. Then there are various hot processes too numerous to detail; continuous heaters in which very little or no chemicals are to be used.

They have just one value, they utilize that wonderful natural force, heat, and they do recover the condensate in the steam which furnishes the heat. But it can do no more than nature allows, and unfortunately is found staggering along under an impossible handicap. If I could have any one element to facilitate my water treatment, I would prefer heat, but I'd like a little soda with it, especially if it was an acid water.

The ideal water method would be a continuous hot-process heater, in combination with intermittent tankage, automatically controlled. That is the tendency toward which we are designing.

And last, we investigated compounds. We investigated many—not all—that couldn't be done, and we found most wonderful and weird combinations (each and all guaranteed to do whatever you wanted done). Some did the little trick with mercury, others used zinc, while others contented themselves with barreling straight silicate of soda and shipping that at fancy prices. In justice to some, however, let me say that they realized that a single analysis of water will not paint a Rembrandt, even though the salesman can, and they are willing to devote their facilities to the solution of your problem. When that is done and you are willing to work with them, I believe the average concern will work out its salvation just as satisfactorily through compounds as it will through hastily or ill-advised mechanical equipment and will at the same time inform itself intelligently as to the correct mechanical method to install, if then desired.

A properly devised compound, synthesized upon correct premises, can be applied to do the work in most waters just about as efficiently as the average mechanical outfit, and it is safe to expect it to work inside the boiler, wherein our final interest lies, and not in the pumps, feed lines, and prime movers. It is all a question of cost to results obtained, and I am frank to say some compounds have nothing to fear from competition.

No general discussion of water manipulation is adequate without at least mention of the tools with which the work is done. Methyl orange is a standard for acids, sulphuric, hydrochloric, nitric, although color variations are difficult to note. Phenolphthalein is better and safer, but is influenced by CO_2. But these are guides that show the way, and can safely be followed.

In addition we have:

Solutions of ammonium oxalate for quick determination of lime.

Solutions of sodium phosphate for quick determination of magnesium.

Solutions of barium chloride for quick determination of sulphates.

Solutions of silver nitrate for quick determination of chlorides.

From various combinations of these can be developed a complete control of elements and the boiler functions dependent upon them.

Just because your sampling tests of feed water appeared satisfactory before being subjected to pressure and temperature, it doesn't necessarily follow that internal tests can be assumed as correct. Test your boiler for internal condition, test it frequently. From these indications, it is not a difficult matter to correct the feed to meet whatever standard you may set.

Graphic Method of Determining Proportions of Coal Mixtures

By Edward J. Clarke

FROM screen tests of the coal in question, the proportion of No. 3 to No. 4 Buckwheat in the mixture may be determined by use of the attached chart.

This chart was obtained by constructing an abscissa scale of 100 equal divisions, and then erecting ordinates through the zero and 100 points, calling the one "straight No. 3," and the other "straight No. 4." Using a convenient ordinate scale, points were located on these ordinates to represent typical screen tests of No. 3 and No. 4.

For example, assume that straight No. 3 screens 70 per cent on 3/32 in., 15 per cent on 1/16 in., and 15 per cent through 1/16 in.; and that straight No. 4

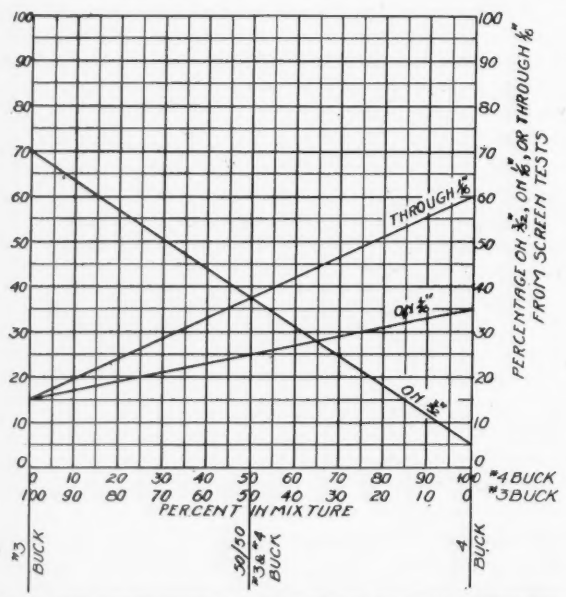


CHART FOR DETERMINING PROPORTIONS OF COAL MIXTURES

screens 5 per cent on 3/32 in., 35 per cent on 1/16 in., and 60 per cent through 1/16 in. Then point 70 on "straight No. 3" ordinate would be joined to point 5 on straight No. 4 ordinate to get the line marked "on 3/32 in." In a similar manner the lines "on 1/16 in." and "through 1/16 in." may be obtained.

To illustrate the use of the chart, suppose a screen test of a mixture of No. 3 and No. 4 Buckwheat showed the following percentages:

On 3/32 in.	36.0%
On 1/16 in.	21.5%
Through 1/16 in.	42.5%
	100.0%

Look up point 36.0 on the ordinate scale to the left of the chart, cross over to the line marked "on 3/32 in." and read the corresponding abscissa, 52 per cent (using upper abscissa scale). This gives the percentage of No. 4 Buck in the mixture, considered solely on the basis of a 3/32 in. screen. In like manner, 21.5 per cent on 1/16 in. gives us 33 per cent No. 4 in the mixture, while 42.5 per cent through 1/16 in. gives us 61 per cent in mixture. Averaging these three percentages (52, 33 and 61), we get 48.6 per cent, so that the composition of the sample in question is 48.6 per cent No. 4 and 51.4 per cent No. 3 Buck.

Instead of using the upper abscissa scale and reading from left to right to get the percentage of No. 4, we could also use the lower scale and get the percentage of No. 3 directly.

For example, using the same screen test as before; 36 per cent on 3/32 in. gives us 48 per cent No. 3 in mixture, 21.5 per cent on 1/16 in. gives 67 per cent No. 3 in mixture, and 42.5 per cent through 1/16 in. gives 39 per cent No. 3. Averaging these three percentages (48, 67 and 39) we have 51.3 per cent as the percentage of No. 3 in the mixture. This checks well with the value obtained before which was 51.4 per cent.

Disposing of Hot Slag

Two accidents occurred in Colorado within a short time, due to the dumping of hot slag in an open dumping ground. In the first incident, an 11-yr.-old barefooted boy sank up to his knees in the hot bed. His feet and legs were burned to the bone ere assistance reached him. Amputation may be necessary.

A five-ton auto-truck was driven into a bed of hot slag. The gasoline tank exploded and owing to the fact that water was not handy, the truck was completely destroyed.

From the foregoing, Safety First demands that it should be arranged to cool the slag before it is dumped, or use a fenced-in dump with a "danger" sign prominent.

Local conditions should suggest the method. but in no case should hot ashes be dumped where there is any likelihood of accidents to humanity, or the destruction of property. J. B. Dillon.

For transmitting energy from its new Pit River hydroelectric development, the Pacific Gas & Electric Co. will use 220,000 as the transmission voltage. The energy will be transformed at the station to this voltage by 16,667-kv.a., 127,000-v., single-phase, water-cooled, outdoor type Westinghouse transformers connected in star for 220,000 v. There will be two banks of three of these transformers, thus making a total rating of 100,000 kv.a. An additional emergency transformer will also be installed to be used on either bank.

"Conceit sometimes puffs a man up to the top, but it never keeps him there."

Power-Plant Instruments and Meters*

An Account of the Purpose of Power-Plant Instruments and Interpretation of Their Records. By E. G. Bailey

INSTRUMENTS and meters are used in the power plant to visualize operating conditions for the purpose of obtaining better efficiency and capacity.

In the past the question of capacity has been emphasized more strongly than has efficiency and it is a matter of prime importance, for the man who maintains a high capacity with every piece of equipment in the power plant is doing the work with a smaller investment and a smaller overhead charge than the man who is letting the boilers and generating equipment drift along at a lower rate and a poorer load factor.

While instruments and meters have been used extensively in power plants, they were largely confined to test work where they were in the hands of an experienced engineer who carefully calibrated and checked up all apparatus before and after the test. Such instruments were practically all indicating, and readings were taken at intervals of time throughout the test.

For a long time, the operating engineer had nothing to visualize his operating conditions, except a pressure gage, a water glass, and the steam-engine indicator. Later, the ordinary thermometer came into general use, and a little later the recording pressure gage and recording thermometer found their way into the power plant and their use has been gradually extended until they are today very prominent as power-plant instruments and are serving a good purpose in a variety of uses.

Classification of Instruments

In comparatively recent years many additional instruments and meters have come into common use. These may be divided into three general classes.

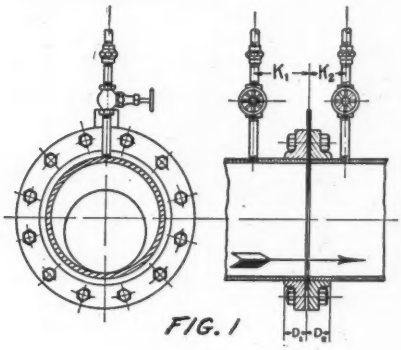
1. Instruments to show condition (indicating and recording).
   - a. Pressure.
   - b. Temperature.
   - c. Humidity.
   - d. Quantity.
2. Meters to indicate or record rate.
   - a. Steam flow.
   - b. Water flow.
   - c. Air flow.
   - d. Stoker speed.
   - e. Fuel supply.
3. Meters to show relation.
   - a. Steam flow, air flow, fuel supply.
   - b. Energy input, work output, turbines, pumps, etc.

The instruments of the first class apply particularly to fluids and material, showing the state or condition of these. Pressure and temperature are the most common factors. Temperature, for instance, is a measure of heat potential showing the state of molecular activity. Pressure is a state of molecular compression. Quantity is used in a varied sense; for instance, a level gage showing the amount of water in a boiler or the amount of coal in a bunker. Integrating meters which show the total quantity up to a certain time also belong to this class.

*Abstract from the July, 1920, proceedings of the Engineers' Society of Western Pennsylvania.

Meters which indicate or record rate are extremely useful in the power plant. We are all familiar with the rapid development that has been made since the venturi meter was first used as a means of measuring feed water. Later forms of flow meters have been developed for measuring steam, gases, oil, etc.

The third item, covering meters which show relation, is the most recent and most important development. The first two classes of instruments and meters give results that are, as a rule, of limited value until they are associated or compared with certain other results. For instance, a boiler may be generating a great deal of steam but doing it very inefficiently with a high flue-gas temperature. It is, therefore, desirable to correlate certain factors which are properly associated so that the operating engineer can see whether or not the best operating conditions are being maintained.



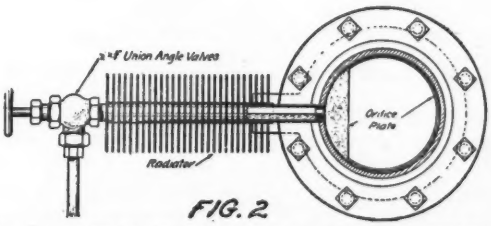


FIG. 1. THIN-PLATE ORIFICE FOR GAS MEASUREMENT
FIG. 2. THIN-PLATE ORIFICE FOR STEAM MEASUREMENT

Indicating vs. Recording Instruments

The question of installing indicating rather than recording instruments is one which most frequently comes up for decision. It has usually been considered that the recorder had its principal advantage in showing the chief engineer or boss what was taking place throughout every hour of the day or night. This is a distinct advantage and is sufficient to decide the matter in most cases. There is also the further advantage that a great deal of valuable information can be obtained from different types of meters and working out therefrom important engineering data. The principal advantage of recording meters over those which indicate only, lies in the fact that the fireman or the operating man

has the chart record before him at all times, enabling him to note whether or not he is maintaining uniform conditions. Recording instruments show in what direction and at what rate conditions are changing, and, for this reason alone, recording instruments have a decided advantage over those which are indicating only.

Accuracy and Care of Instruments

One of the first and most important points to be considered in connection with instruments and meters

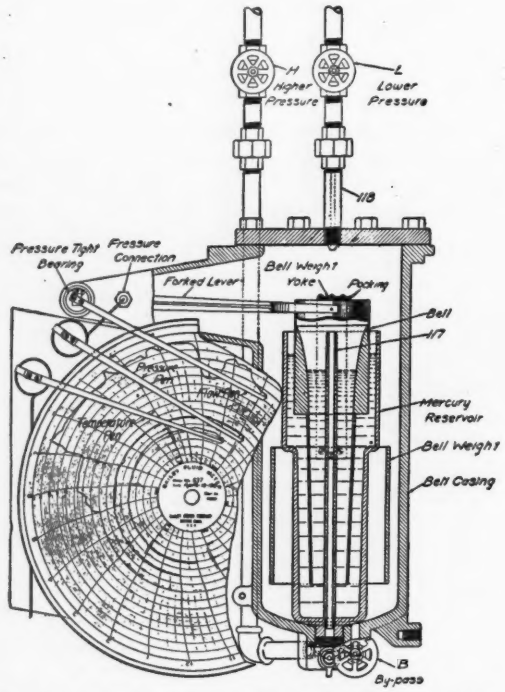


FIG. 3. FLOW METER WITH BELL SUBMERGED IN MERCURY

is their initial accuracy and their reliability in maintaining this accuracy. Unless the readings are reasonably accurate they are worthless.

Many instruments and meters installed in power plants have been of little or no value because the operating engineer failed to give them proper attention. The operating engineers who do not produce value from instruments and meters may be divided into three classes:

First, the man who is entirely unfamiliar with meters and instruments and who is afraid to touch them for fear he might damage them. Second, the one who fears nothing of this kind and does not hesitate to take any instrument entirely apart without reading instructions. Third, the one who is too busy to pay any attention to the instrument or meter. Often, in case of failure or inefficiency, a meter may be showing him exactly what is wrong with his plant, yet he is not sufficiently acquainted with its readings to interpret the results indicated.

The real solution is to place the power-plant instruments in the hands of somebody who is thoroughly familiar with them. The duties of this man are threefold:

First, to make sure that the instruments are in proper adjustment. Second, to interpret correctly the readings and to instruct the fireman and operating engineer how to obtain the desired results. The third function of this "results engineer" is to calculate, plot, and tabulate the results in such a form that he can keep a reliable check on all equipment, so that he can recommend improvements.

There is a real field for such men and their efforts are going to be appreciated by those who are controlling the financing of power plants and industry.

Flow Meters

Of the second class of meters, as also of the first, there is a very general knowledge today, but in regard to the orifice type of flow meters there are a few points that are not fully understood by all power-plant men. These it might be well to explain briefly.

The sharp-edged orifice has been calibrated and used a great deal for measuring water and air flowing from tanks and reservoirs, usually designed for high-pressure differentials. Its successful use, in pipe lines was limited, however, to very low capacities, or, in other words, to cases where the ratio of orifice diameter was small. Those who first used the thin-plate orifice between a pair of pipe flanges for measuring flow of fluids at high velocity, found very discordant results. Subsequent experiments have shown that this was due to the fact that a

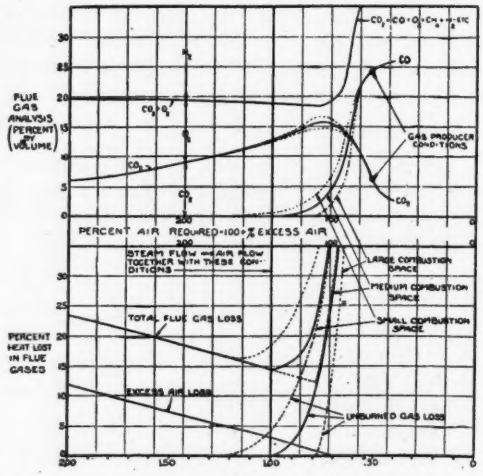

FLUE GAS ANALYSIS (PERCENT BY VOLUME)
CO
GAS PRODUCER CONDITIONS
PERCENT AIR REQUIRED=100+% EXCESS AIR
STEAM FLOW AND AIR FLOW TOGETHER WITH THESE CONDITIONS
LARGE COMBUSTION SPACE
MEDIUM COMBUSTION SPACE
SMALL COMBUSTION SPACE
TOTAL FLUE GAS LOSS
PERCENT HEAT LOST IN FLUE GASES
EXCESS AIR LOSS
UNBURNED GAS LOSS

FIG. 4. DIAGRAM ILLUSTRATING FLUE-GAS ANALYSIS, AND HEAT LOST IN FLUE GAS

great deal depended upon where the pressure connections were made; the principle was the same as with the venturi tube.

Figure 1 shows an orifice located in a horizontal gas line. The opening is circular, but eccentric with regard to the pipe, so that the hole is flush with the bottom of the pipe with no chance for condensation to accumulate. The pressure connections are taken out from the top of the pipe and may be connected to any form of indicating or recording meter.

A similar type of orifice is used for measuring dirty water, the connections being made from the side of the pipe instead of the top, in order to prevent accumulation of air pockets.

The orifice shown in Fig. 2 is segmented, having a

narrow annular ring around the edge of the pipe, the dam or restricting portion being a segment immediately in front of the pressure connections. In the case of measuring steam the pressure connection pipes are usually at the side so as to be free from accumulated air and also to form a reservoir for maintaining equal water level in the two connecting pipes. A radiator is supplied so that as soon as there is a displacement of water caused by the motion of the meter, steam is condensed to take its place and maintain equal water level in both pipes.

The orifice, as well as the pitot and venturi tube produces a differential pressure proportional to the square of the velocity of the flowing fluids. The extremely small differential at the lower rates of flow, makes it difficult to secure the desired accuracy over the lower ranges. For instance, the differential pressure is only 1 per cent of the maximum when the rate of flow is 10 per cent of the capacity of the meter.

Figure 3 shows a specially shaped bell which is sealed in mercury, and weighted on the outside of the mercury reservoir so as to be submerged to the point of greatest diameter in the position of zero flow. The higher pressure from the inlet side of the orifice is connected through the center pipe to the interior of the bell, while the lower pressure comes into the meter casing. When metering steam or water, the entire casing and connecting pipes are filled with condensed steam.

A slight differential pressure produced by the lower rates of flow introduces a force over the entire area of the bell, pushing it upward. As the bell rises to the position shown in the diagram, the differential pressure corresponding to the change in mercury level, within and without the bell, pushes the bell upward until the emerged volume of the walls of the bell equals the volume of mercury displaced in the interior. The shape of the bell is so designed that the motion is directly proportional to the rate of flow.

Meters to Show Relation

The third class of meters showing the relation between different factors has been developed for the purpose of giving the power-plant operator the maximum amount of condensed net results directly.

In the case of combustion, to know merely the steam flow and the percentage of CO_2 is not sufficient because it is very seldom that the highest percentage of CO_2 which can be obtained is that which should be striven for. Figure 4 shows a diagram of gas analysis running from about 180 per cent excess air to a deficiency of some 25 per cent which represents producer gas conditions. It will be noted that the percentage of CO_2 falls off rapidly after the point of theoretical air supply is passed. In the case of furnaces having limited combustion space, CO_2 and unburned gases may start to form with an air excess of 60 per cent and a CO_2 content of 11 or 12 per cent. In this case the most economical condition of fuel bed would be one which would produce these results while giving neither more excess air nor much unburned gas. The average of the better modern practice is shown in this diagram as the one corresponding to medium combustion space where the excess air can be reduced to 40 per cent above the theoretical before the unburned gas is formed to any appreciable extent. This corresponds to about 13 per cent of CO_2. It is obvious from the diagram that the combustion should be maintained at this point.

Under these ideal operating conditions, a definite amount of air is required to support combustion. We may, therefore, speak of the heat produced per pound of air. This heat is capable of generating a certain amount of steam. We may, therefore, compare the amount of steam produced with the amount of air used for combustion and obtain a very reliable indication of the efficiency of the combustion.

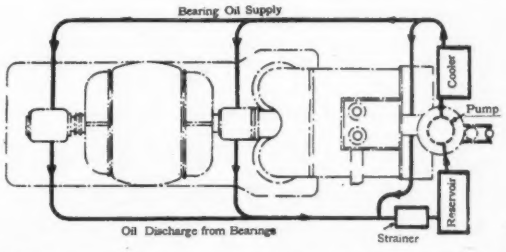
This has been accomplished by a meter which records the steam output from the boiler reading directly in per cent and also records the rate of air flow through the boiler passes.

Other types of meters belonging to this class include the rate of stoker speed, as well as steam flow and air flow, the latter being adjustable according to the evaporation per pound of coal, so that stoker speed readings should be synchronous with the steam and air flow, as long as the coal is being burned at the proper rate to carry the load.

Lubrication of Steam Turbine Bearings

By H. V. Schoepflin

For the proper lubrication of the various bearings of a steam turbine unit, it is vitally necessary that a continuous supply of clean pure oil be maintained at a few pounds pressure, at the same time providing efficient means for carrying off the heat generated in the bearings. It has been found that one of the most satisfactory methods of cooling the bearings is to cool the oil itself before the bearings are supplied, the heat generated being thus transferred to the oil, which is then



ARRANGEMENT OF TURBINE OIL-COOLING SYSTEM

returned to the system and recooled before it again reaches the bearings. In order to prolong the life of the oil, the reservoir which contains the supply must be of ample capacity so that the oil may have as long a period of rest as is possible between the times of actual use in a bearing. By providing a strainer in the discharge line from the bearings, to remove any foreign matter from the oil before it is returned to the reservoir, a constant supply of clean lubricant is assured, although occasional filtering is necessary to remove impurities which pass through the strainer. In some of the more elaborate oiling systems a partial filtration system has been added, providing for a continuous purification of a small percentage of the oil actually in use, which small amount is being constantly drawn out from the bottom of the reservoir and returned to the system after it passes through the filter.

The oil circulation is maintained by means of a pump, which is positively driven from the governor spindle by spur gearing, the governor itself being worm driven by the turbine shaft. In order that the oil supply may be maintained when starting or stopping the turbine, the pump is supplemented by an auxiliary pump, which is usually steam driven. The procedure when starting up the unit is first to start up the auxiliary pump, the turbine spindle not being turned over until the bearings are flooded with oil; then, when the turbine reaches full speed and the main pump has attained full capacity, the auxiliary is shut down, and the main pump supplies the system as long as the turbine is running. This procedure is, of course, reversed when shutting down the unit.

A common arrangement of cooling system in general use on steam turbine units of modern design is shown in the accompanying illustration. The oil is pumped from the reservoir through the cooler, which is composed of a nest of tubes, to the bearings. The cooling water is forced through these tubes at high velocity and the oil circulates outside the tubes, rapid and efficient cooling being thus assured. After being discharged from the bearings the oil, now at a slightly increased temperature, is carried by gravity through the strainer to the reservoir, from where it is again pumped through the complete cycle repeatedly.

Where the governor valves of the turbine are operated by an oil relay system, it is necessary to provide oil at a fairly high pressure for use in the operating mechanism, and the pump must consequently be designed for the higher pressure. In such cases, the oil is first pumped into a surge tank, where the proper pressure for supplying the valve operating mechanism is maintained by means of a spring loaded relief valve. The discharged oil, together with that escaping from the surge tank through the relief valve, passes through the cooler and thence to the bearings. Otherwise, the oiling system is identical with that first described.—The Electric Journal.

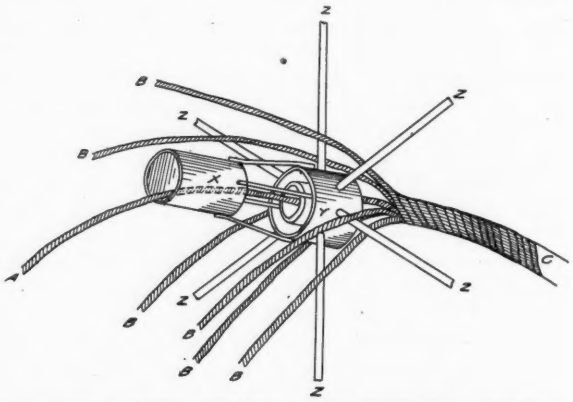
Simple Device for Stripping Out Inner Strand of Steel Cable

AN interesting salvaging operation was recently carried out successfully by the Spanish-American Iron Company in Cuba. The inner strand of a 3-in. steel cable which had been condemned and discarded because of worn and frayed outer strands was salvaged and the worn strands cut into 6-ft. lengths for the charging box. Both the inner strand and the scrap were well worth saving, as the cable was a mile and a quarter in length and the reclaimed strand (1¼ in. in diameter) was practically as good as new.

The problem involved was to cut away the six worn strands without damaging the valuable inner strand. This was accomplished by means of a simple but ingenious device constructed on the ground out of convenient scrap metal. Suitable lengths of iron pipe, of a size convenient to grip with the hand, were welded into the rim of a small iron pulley in such manner as to resemble spokes in the hub of a wheel with tire and felloes missing. A short section of sheet iron pipe, slightly smaller in diameter than the pulley but larger than the shaft bore, was then welded to it in line with the bore by the use of four strips of strap iron.

The strands of the cable were then pried apart for a few feet to admit of passing the inner strand through the hub and its extension and the feeding of the outer strands through the six spaces between the spokes. With the strands so adjusted, the device was revolved against the wind of the cable and advanced as the strands unwound, the inner strand being allowed to lie in a continuous length along the course of the work and the worn members being easily cut into charging-box size with the oxy-acetylene torch. The length of the spokes gave the necessary leverage for hand operation of the device. The cable, of course, remained stationary, the inner strand being coiled and the scrap collected after the work was completed. The job was done in jig-time, the oxy-acetylene flame snipping off the worn strands with almost chopping speed.

The device is developed in detail in the accompanying figure. A represents the inner strand of the cable; B, the worn outer strands; C, the body of the cable;

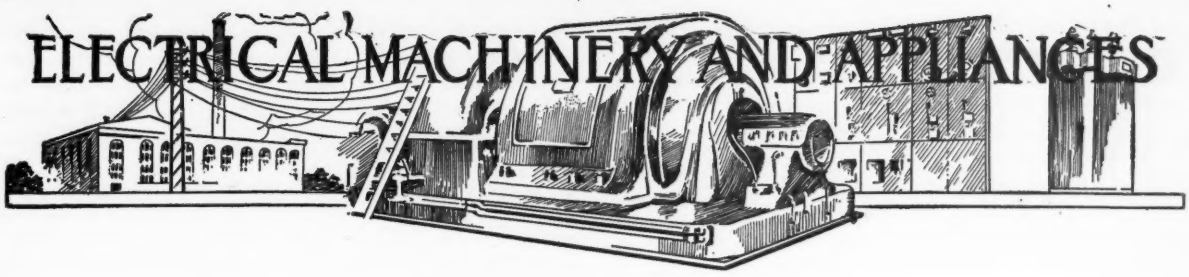


HOW THE DAMAGED STRANDS WERE UNWOUND, PREPARATORY TO BEING BURNED INTO SCRAP LENGTHS

X, the pipe extension of the hub; Y, the pulley used as hub; and Z, the spokes. It was made with practically no cost for material, being composed entirely of scrap, and with little outlay for labor. It affords an interesting example of the resourcefulness of the American mechanic, John Cranford, who was in charge of the work.

The use of the pulley and pipe extension was necessary only because a suitable length of pipe was not at hand. A single section of pipe of the right size to allow for welding in the spokes and long enough to keep the inner strand from curling would be much simpler and would serve the purpose equally well.

U. S. Civil Service Commission announces an examination for safety engineer, to fill a vacancy at the Navy Yard, Boston, Mass., at $8 a day, plus increase granted by Congress of $20 a month after one month's service, and vacancies in positions requiring similar qualifications, at this or higher or lower salaries, receipt of applications to close Nov. 30, 1920. Applicants must have reached their twenty-fourth but not their fiftieth birthday on the date of the examination. Age limits do not apply to persons entitled to preference because of military or naval service. Apply for Form 2118, stating the title of the examination desired.



Static Condensers

THEIR CONSTRUCTION AND THEORY OF OPERATION. BY VICTOR H. TODD

IN DIRECT-CURRENT work, the true watts consumed by any piece of electrical apparatus may be easily calculated by multiplying the amperes by the volts. But this is not always true in alternating-current work, as there is another factor by which the product of volts and amperes must be multiplied in order to arrive at the true watts. This factor is called the "power factor" and may vary anywhere from 0 to 1. For instance, if an ammeter and voltmeter are connected in an alternating current circuit, the ammeter may show 5 amp. and the voltmeter 100 v. Their product (500) is called "apparent watts" and this apparent wattage multiplied by the power factor gives the true watts. In this example, if the power factor were 0.5 (or 50 per cent), then the true watts would be $5 \times 100 \times 0.5 = 250$ true watts.

It is a well known fact that the power delivered by an induction motor depends on the true watts and not on the apparent watts; and yet, on the other hand, the heating losses in line, transformer and generator are proportional to the square of the current. Consequently, if it takes 5 amp. at 50 per cent power factor to deliver 250 w. to a motor and it only takes 2.5 amp. to deliver

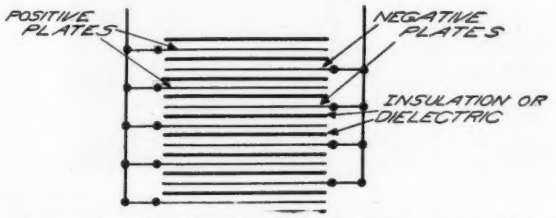


FIG. 1. SHOWING ARRANGEMENT OF PLATES AND DIELECTRIC IN A SIMPLE CONDENSER

the same power at 100 per cent power factor, it is quite evident that the losses in line, transformer and generator will be approximately four times as great at 50 per cent as at 100 per cent power factor. This is one reason why it is so important to have a high power factor.

Another reason is that the lines, transformers and generators are limited by the current they can carry and not by the actual wattage delivered to the motor. For instance, if a generator can deliver 500 amp. at 1000 v., then if the power factor of the load is 100 per cent, the generator can deliver 500 kw. But if the power factor is only 50 per cent the same generator still carrying the same current, can deliver only 250 kw. The same reasoning applies to the capacity of lines and transformers. This may be viewed from a different angle if desired by considering two industrial concerns which require a certain amount of power, say, for example, both mills require a total power input of 250 kw. each. The voltage in both cases is 1000 v. The first consumer installs lamps, induction motors, and power-factor corrective devices so that the load is 100 per cent power factor. Consequently the electrical company must build a line to carry 25 amp., install transformers of 250 kv.a. capacity and install a generator which will deliver 25 amp. at 1000 v.

But the other consumer installs only induction motors and his load has a power factor of only 50 per cent. Now the electric company must build a line to carry 50 amp.;

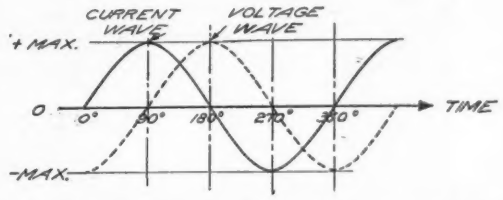


FIG. 2. CURRENT LEADING VOLTAGE 90 DEG. IN A CONDENSER

must install transformers of 500 kv.a. capacity and a generator to deliver 50 amp. at 1000 v. In addition, the losses in delivering 250 kw. to the second customer are much greater than to the first customer.

Obviously it is not fair to charge a customer with a high power factor load as high a rate as a customer with a low power factor load and this is why central stations are penalizing for low power factors and why the up-to-date industrial concern should install corrective apparatus to bring its load up to or near unity power factor.

OTHER BAD EFFECTS OF LOW POWER FACTOR

LOW POWER FACTOR also has a deleterious effect on the regulations of transformers. For instance, if the voltage drops 1 or 1½ per cent from no load to full load with a 100 per cent power factor load, then with a load at 70 per cent power factor the voltage drop may be about 3 or 4 per cent from no load to full load.

The effect on the generator is even worse as most generators are designed with exciters to give their rated voltage with a load at 80 to 100 per cent power factor. Now if the power factor goes below this, the lagging current has a demagnetizing effect on the field and the exciter voltage must be raised to get the proper alternating-current voltage. This demagnetizing effect is so great that in some cases it has been necessary to get

entire new exciters in order to get the proper alternating-current voltage at a low power factor. So it will be seen that the low power factor causes the following bad effects in the generator:

1. Decreased kw. capacity.
2. Decreased efficiency.
3. Impaired voltage regulation.
4. Increased exciter capacity.
5. Increased field losses.
6. Increased energy input per kw. output.

Cause of Low Power Factor

Now that the ill effects of low power factor have been demonstrated, let us consider their causes. Without going into a demonstrative proof, it may be stated that low power factor may be caused by the instantaneous peak of the current wave occurring before or after the instantaneous peak of the voltage wave. In other words, the current is not in phase with the voltage, but either leads or lags. Therefore a low power factor is spoken of as a leading power factor or a lagging power factor.

In lamps and heating apparatus, there is nothing to throw the current out of phase and consequently this kind of a load will have a power factor of 100 per cent. But in the induction motor, the current lags considerably depending on whether the motor is running lightly or heavily loaded. If running without load, the power factor may be as low as 12 or 15 per cent but as the load is increased, the power factor rises until it may be 80 or 85 per cent at full load. Thus, if a motor is selected to drive a certain machine, and this machine only imposed half load on the motor, the power factor of the motor may be only 40 or 50 per cent. If all the motors in the factory or industrial concern are running light or idle, or only partly loaded, it follows that the total power factor of the entire installation will be low.

Correction of Power Factor

The current in an ordinary condenser (made-up tinfoil and paper in alternate sheets as shown in Fig. 1), will be found to lead the voltage by about a quarter of a cycle or 90 deg. This is shown in the curves in Fig. 2. It will be noticed that the current passed through the values of + maximum, zero, —maximum, and zero, about 90 deg. ahead of the similar voltage positions.

Now, let us connect a condenser which takes a leading current of 5 amp. at 100 v. in parallel with a load that takes a lagging current of 5 amp. at 100 v. It is evident that the current in one will still lead and the current which is drawn from the line cannot both lead and lag. Therefore the current drawn from the line will be the resultant and as shown in Fig. 4 if the amount of leading and lagging currents are so proportioned, the resultant may be thrown in phase with the voltage and now, even though the load has a low power factor lagging and the condenser has a low power factor leading yet the power factor of the two combined or the power factor of the whole installation may be near 100 per cent.

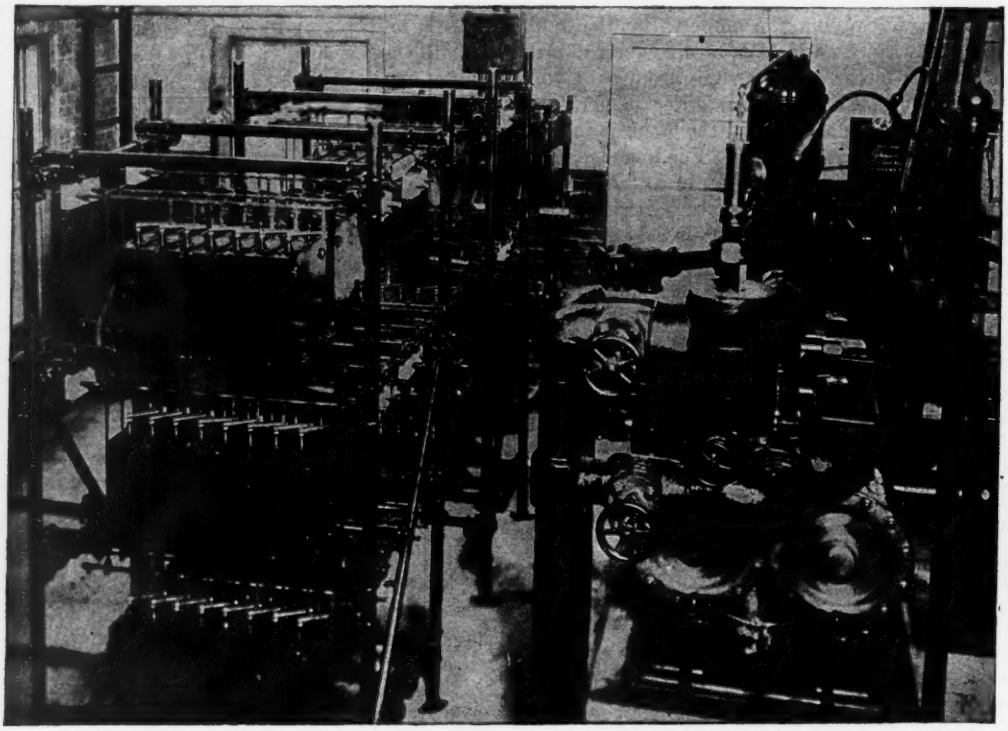


FIG. 3. TWO 100-KV.A. STATIC CONDENSERS—PHOTO COURTESY GENERAL ELECTRIC CO.

The Static Condenser

Realizing the importance of having a high power factor, a static condenser for the correction of low power factor has been perfected. This is shown in Fig. 5.

It consists of an immense number of sheets of metal foil and paper arranged like the unit shown in Fig. 1. The condenser equipments for 2300-v. service consist of a number of condenser units; a reactance for damping out higher harmonics in the wave which might affect the corrective capacity; a resistor of high resistance for draining the condenser when it is disconnected and an oil circuit breaker for connecting and disconnecting from the line. A fuse is also used in the connection of each couple and this fuse not only protects the bank from excessive current in case of ground or breakdown but also serves as a handy method of varying the capacity of the outfit to meet the needs of the load, for instance in a factory which runs heavy in the winter and light in summer; then a number of fuses could be removed in the summer time.

Each condenser unit or couple is made up to give a definite capacity. These couples are all treated under vacuum to withdraw all moisture, immersed in oil and then the container hermetically sealed to prevent any possible absorption of moisture from the air. These units are all connected in parallel for single phase. For two phase, two equal sets are used, one across each phase, and for three phase, three equal sets are used, one across each phase. The diagrams of connections are shown in Fig. 5.

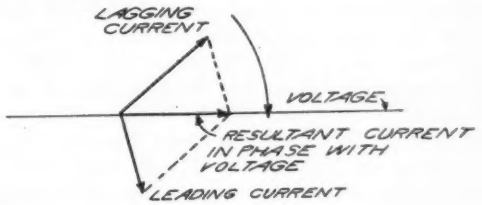


FIG. 4. SHOWING HOW THE RESULTANT MAY BE IN PHASE

For use on a 2300-v. circuit, the static condenser has an efficiency of about 99½ per cent, as the losses are extremely low.

On a 220, 440 or 550-v. circuit, however, resort is made to autotransformers to step up the voltage to 1200 v., which is the safe working limit of the dielectric and of course it will be borne in mind that the corrective capacity is proportional to the square of the voltage, thus getting the maximum service from a minimum of active material. The auto transformer is designed with

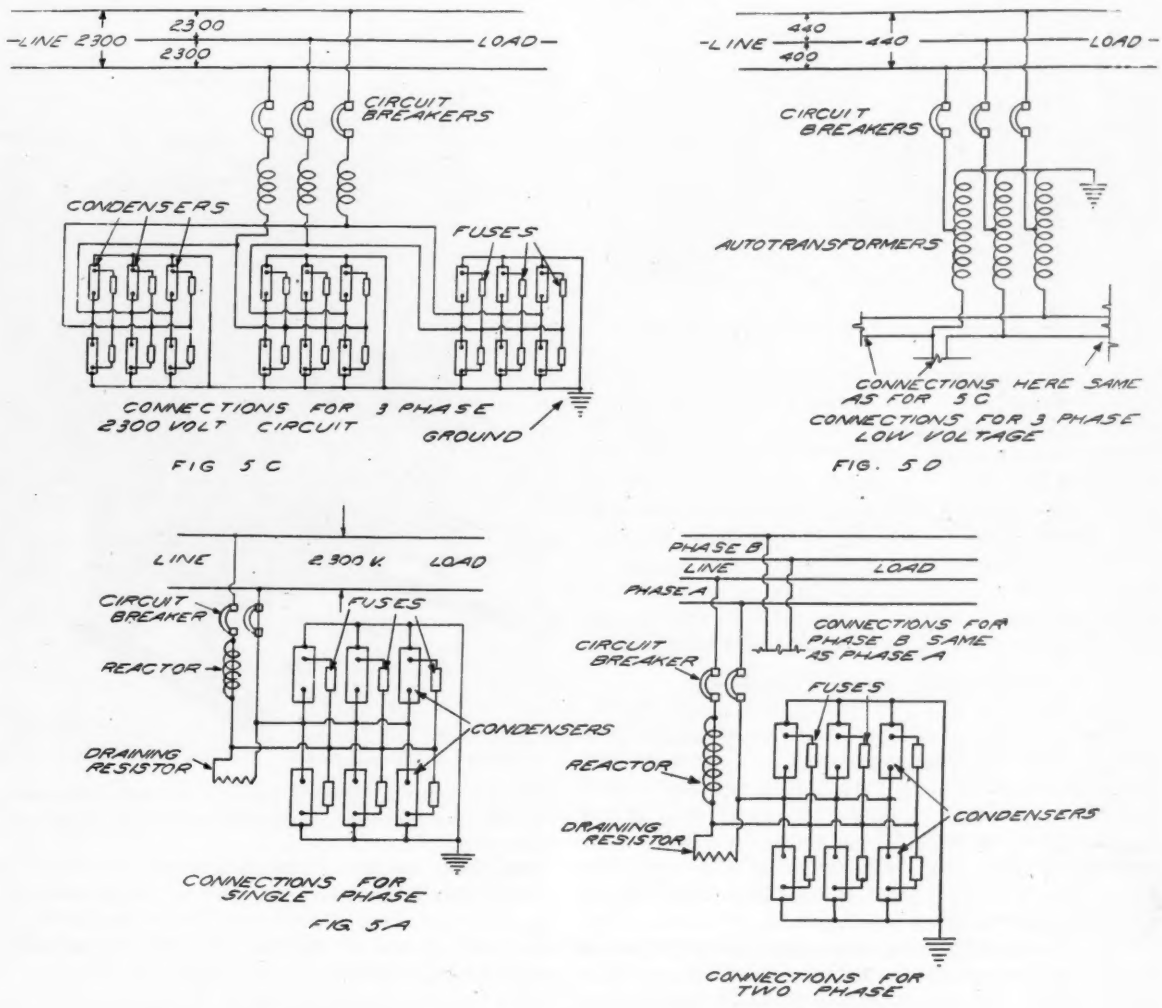


FIG. 5. CONNECTIONS OF STATIC CONDENSER ON SINGLE, 2- AND 3-PHASE CIRCUITS

an inherent reactance of such a value to dampen out any objectionable harmonics that may be set up when the condenser is connected to the line. This auto transformer also serves as a discharge path for the condenser when it is disconnected thus eliminating an extra draining resistor. Consequently the low voltage outfits require neither separate reactors nor draining resistors as in the three phase. However, due to the use of auto transformers with their attendant losses, the efficiency of the low voltage outfit is about 97 per cent, which is, of course, higher than the best synchronous condenser.

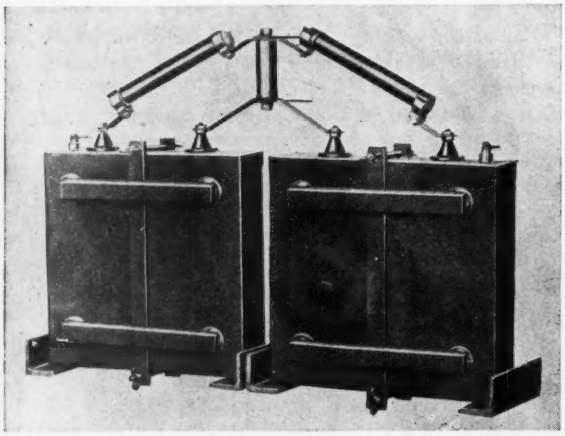


FIG. 6. SINGLE COUPLE OF STATIC CONDENSERS

The units necessary are directly proportional to the capacity desired, each unit having a capacity of 5 kv.a. at 60 cycles. The outfits have been standardized for installation on circuits from 40 to 125 cycles, with voltages from 220 to 2300 v. and in capacities of from 30 to 300 kv.a., the smaller sizes being 30 and 60 kv.a., and then increasing in steps of 60 kv.a. each, to 300 kv.a.

Voltages above 2300 v. require transformers to step down to 2300 v. to enable static condensers to be used, and a suitable oil circuit breaker must be used to control the apparatus from the line side of the transformers.

Operation of Static Condensers

THE OPERATION of static condensers is simplicity itself and no extra attendant is required. To place the condenser in service, the oil circuit breaker is simply closed; to take it out of service, the breaker is opened. It may be left on the line indefinitely and may be installed in an unused out-of-the-way place, simply giving it an occasional inspection to see that it is in good condition and functioning properly.

No special foundation is necessary as there are no moving parts and the foundation must bear only its dead weight. Its operation is practically noiseless and the heating is only about 10 deg. C. rise above ambient temperature. As long as normal voltage is obtained, it is impossible to overload the static condenser; but it must be borne in mind that the corrective capacity is proportional to the frequency and to the square of the voltage although the outfits are designed to function properly on voltages varying 10 per cent above or below the rated voltage of the equipment.

Cost of Copper vs. Condensers

THAT THE static condenser is a saving and not an expense may be shown from a simple example of the calculation of the cost of the extra copper necessary to transmit a load of 100 kw. at 2300 v. 3-phase 60 cycles at 60 per cent power factor, over the same load at 90 per cent power factor. Assuming a distance of about 2 mi. and a 10 per cent line loss, the circular mils necessary at 60 per cent power factor would be 69,500 while at unity or 100 per cent power factor it would only have to be 25,000. At 90 per cent power factor the required circular mils would be 30,280.

A simple calculation will show that the line for 60 per cent power factor will require 3600 lb. of copper more than the line for 90 per cent power factor transmission and with copper at about 20 cents per pound, it means that copper alone will cost about $720 more.

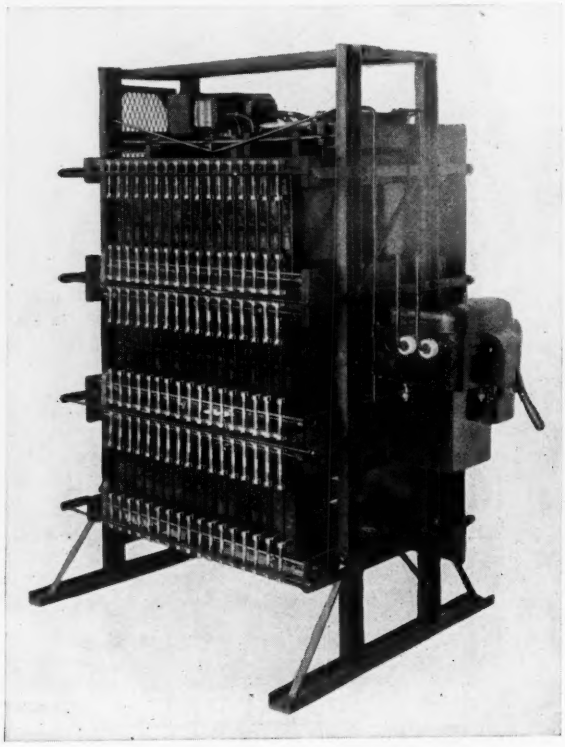


FIG. 7. 50-KV.A. 2300-V. INDOOR STATIC CONDENSER—PHOTO COURTESY ADIRONDACK POWER & LIGHT CO.

This alone is almost equal to the cost of a static condenser installation, and when to this is added the saving in decreased kv.a. capacity of both transformer and generator, it will be realized that static condensers are indeed an economy.

Condenser Calculations

IN MAKING calculations for power factor corrections, there are a number of points to be considered. The first is to raise the power factor as high as possible by correct apportionment of motor loads and the minimum average and maximum loads and their power factors must be taken into consideration. Then the effect of a leading current can be more accurately determined.

It is desirable to locate static condensers as near the source of the inductive load as possible in order to avoid an excessive flow of current between condenser and load, and for this reason it may be preferable to install several small sets at various locations instead of one large set at a central location.

Assume for example that it is desired to raise a 300-kw. load at 60 per cent power factor to 90 per cent. This load will have an apparent wattage of 300 divided by 0.6 or 500 kv.a. and the wattless component will be equal to $\sqrt{500^2 - 300^2} = 400$ kv.a. The 300-kw. load at 90 per cent power factor would give an apparent wattage of 300 divided by 0.9 or 333 kv.a. and the wattless component would be $\sqrt{333^2 - 300^2}$ or 145 kv.a. The difference 400 — 125 = 255 is the leading kv.a. that will be necessary to raise the power factor from 60 to 90 per cent.

Practicability of the Static Condenser

That the static condenser is a practical device and giving uniform satisfaction to the users, is evinced by the replies received by the writer to a questionnaire sent regarding their satisfaction. Without exception, the companies using static condensers, report the most favorable results and some claim that the condensers are all and even more than the manufacturer claims them to be. For these reasons, the static condenser should appeal strongly to every plant having a low power factor to correct, especially in isolated plants, as their use in many cases may obviate the necessity of additional generator, transformer and line capacity, and they will always contribute to maintenance the highest possible efficiency in both generating plant and distribution system.

The subject of correction of low power factor by means of the synchronous loaded motor as well as the subject of vector diagrams and tables showing how to calculate the necessary corrective capacity, and the primary capacity rendered available by the addition of corrective devices will be taken up in a later article.

Tests for Grounds on Interior Wiring Installation

By J. V. Shannon

MANY public utility companies follow the practice of testing for grounds on the interior-wiring circuit each time the watt-hour meter at the installation is tested. The method which is usually followed is that shown in Fig. 1. At I is indicated the interior installation. The secondary circuit is, usually, as shown, at G_p, grounded. An accidental ground, G_a, is indicated in the interior wiring.

Now, to test for this ground, G_a, the meter tester removes the house leads from the meter and twists them together as shown at T. Then, he connects his test lamp, L, between the live side of the line and T. If the ground at G_a is of sufficiently low resistance, his test lamp will light. Sometimes grounds on interior wiring are of such high resistance that they will not "light a test lamp." In such a case, a rotating standard (a watthour meter testing instrument) is inserted as shown at R, Fig. 2-I. By following the directions which accompany the rotating standard, it is possible, by counting the number of revolutions which the pointer of the instrument makes in a certain period of time, to determine the watts power consumed by the ground. Then the voltage of the circuit being known, the current flowing may

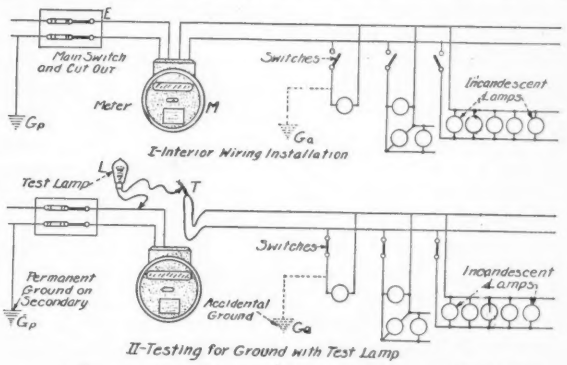


FIG. 1. TESTING FOR A GROUND WITH A TEST LAMP

be ascertained and from the current and voltage values the resistance of the ground, in ohms, can be computed.

The above-described methods apply particularly to alternating-current installations. For direct-current work, a millivoltmeter can be used somewhat as indicated

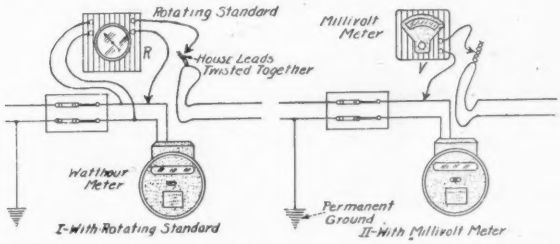


FIG. 2. APPLICATION OF A ROTATING STANDARD AND A MILLIVOLTMETER

in Fig. 2-II. The resistance of the ground on the interior-wiring circuit can be computed in ohms by following the usual method for ascertaining the value of a high resistance with the millivoltmeter.

New Motor Starter Embodies Many Interesting Features

OF recent development is a new type of automatic motor starter, designed for general use in controlling series, shunt and compound wound direct-current motors employed to drive pumps, line shafts, compressors, blowers, conveyors, etc. The complete equipment for one starter consists of a panel upon which are mounted from one to three series accelerating contactors, the last closing having a shunt holding coil and a normally open electrical interlock, together with one starting resistor. Some of the forms also include a line switch for starting; but where this is not the case, one must be installed separately.

The lower end of armature A is situated between poles D and F, of which D has the shorter gap as determined by brass pin J fastened to D and holding the armature at a fixed distance.

The spring between armatures A and B is adjusted by calibrating screw E, this screw being held in position as set, by spring 5 which falls into the grooves of the knurled head of the screw.

Screw E is turned clockwise to increase the spring

pressure and thereby obtain a high current limit setting, or closing point, and counter-clockwise for a low current limit setting.

Actuating coil C is connected in series with the armature of the controlled motor and when current higher than that for which the contactor is adjusted is switched on, armature B closes against its pole face and exerts through the compressed calibrating spring a closing pressure against armature A. This spring pressure, however, against armature A cannot overcome the opposing magnetic attraction of pole piece D until the motor accelerates and the current falls in value to the point, as determined by the spring setting, where D releases. Armature A is then drawn against pole F by the compressed spring and the pull of the pole and is held there by magnetic attraction. This action closes contacts T and short-circuits that part of the starting resistor which is connected between them.

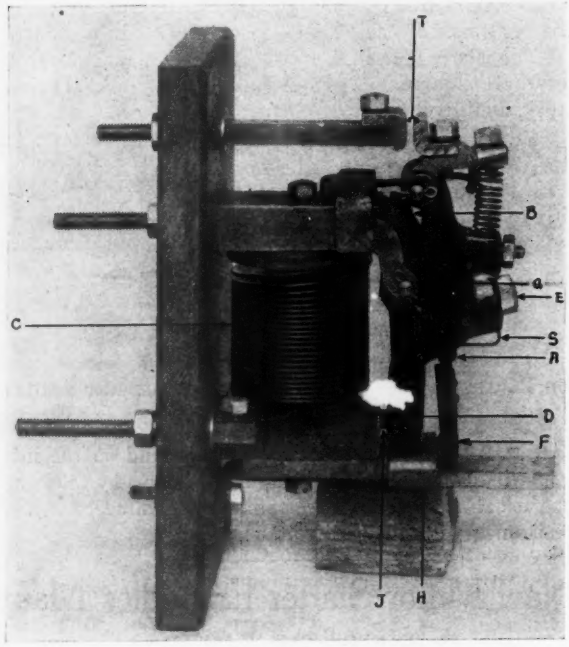


FIG. 1. A RECENTLY DEVELOPED MOTOR STARTER

The air gap of the contactor is so short that its operation is not affected by stray fields.

The shape of the contact tips, which gives them a rolling contact, and the strong spring pressure minimizes trouble from pitting and insures a low resistance contact.

The starters are further provided with terminals for energizing extra circuits which may be used for pilot lights for energizing solenoids to unload compressors during starting, etc.

Operation of the starter is very simple. When the line switch is closed, the whole starting resistor is put in series with the motor armature, and contactor 1. When the initial rush of current is decreased to the value for which contactor 1 is set, the contactor closes, shorting out the first division of the starting resistor 2. The same process is repeated until the last contactor is closed.

When it closes it short-circuits all starting resistance and the series coils of all contactors applying full voltage to the motor armature. The last contactor to close is held in place by means of the auxiliary shunt-wound holding coil.

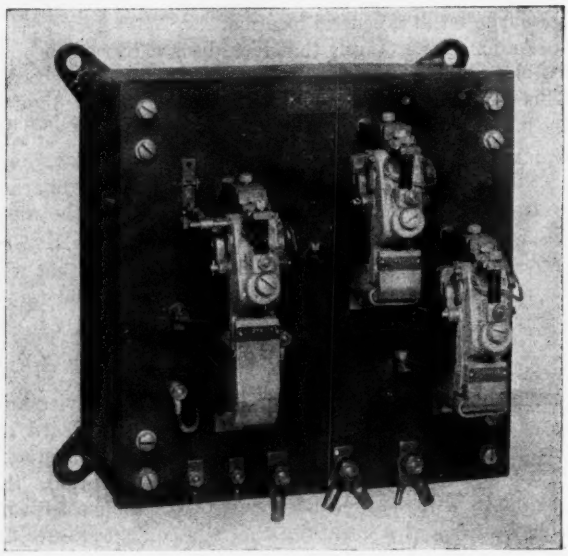


FIG. 2. APPLICATION OF NEW MOTOR STARTER RATED AT 25 HP. 230 V.

When it closes, the voltage is applied direct to the motor armature, the series coil of the contactors is short-circuited but the contactor closed. All the other contactors open as their series coils are short-circuited. In cases of failure of the voltage, the last contactor will open.

Filling Commutator Pits

EXCESSIVE sparking of generators and motors is detrimental alike to brushes and commutator and while the former can, by the proper application of sandpaper, be put into working condition without much trouble, the damage done to the commutator is frequently of such character as to cause much concern on the part of the attendant. This is particularly true where pitting has occurred due to a heavy short circuit, a flashover or a discharge of lightning.

Ordinarily, the depth of a pit of this kind is such that turning down of the commutator would mean the total loss of the member and allowing the pit to remain results in an accumulation of carbon and copper dust, the presence of which merely aggravates an already bad situation.

Matters can, however, be quite readily remedied in a simple manner by thoroughly cleaning out the pit with some sharp pointed instrument and filling the cavity with plaster of Paris. If this is not available, a mixture of shellac and ground mica may be employed instead.

After allowing sufficient time for the mixture to harden, the armature is set in motion, the sandpaper block applied and the surface of the filling thus flush with that of the commutator.

A mixture of the white of an egg and ground mica is also applicable for this purpose.

Increasing Conductivity and Reducing Fuel Consumption*

IMPORTANCE OF CLEAN HEATING SURFACES AND METHODS OF CLEANING. BY WM. R. VAN NORTWICK†

DUE to its scarcity and high price, the problem of fuel conservation is today receiving more attention than at any time in the past. Great thought has been given to the development of the modern stoker so as to get every heat unit out of the fuel and into the furnace. Thousands of dollars have been spent by the boiler manufacturers in order to take the heat units from the furnace and turn them into increased steaming capacity. One of the well known boiler companies recently spent over a year experimenting and testing in order to ascertain the most efficient type and arrangement of the baffles.

Makers of prime movers, generators and motors retain expensive designing and testing departments to add a fraction of a per cent to the efficiency of their products. While all this expense and refinement in design naturally is more than returned in the form of reduced fuel consumption, a great many plants are wasting materially larger amounts through lack of attention to the continually decreasing conductivity of the boiler.

The ideal design of a steam generator would be one in which the fire would come in direct contact with the water—with no wall of metal between. Of course this is impossible and we are compelled to interpose the wall of metal between the fire and the water. Great pains have been taken to reduce this wall to its smallest possible thickness with a maximum conductivity.

The very operation of the boiler, however, tends to decrease the ability of the boiler to transmit the heat units from the fire to the water with a constant decrease in efficiency and increase in fuel consumption to accomplish a given result. This is due to the soot deposited on the tubes from the fire and the scale deposited from the water.

The fuel in burning produces a fine soot or ash which, carried by the draft, finds lodgment on the top of the tubes of a water-tube boiler or in the flues of a fire-tube boiler. The steam lance has been used in plants for some time principally to blow the soot from the tubes when it had accumulated to such quantities as to interfere with the draft and tended to slow down the fire. The fact that there is only one insulator more efficient than soot had apparently escaped notice and the soot was allowed to remain on the tubes in sufficient quantities to cause a considerable fuel loss. Today the use of the mechanical soot blower is becoming more common although there are many boilers today which are not so equipped.

The soot which is referred to is not necessarily unconsumed carbon, but is more often ash. It resembles but little our conception of soot in that it is more often white, red, brown, gray or green than black. The soot often fuses at fairly low temperatures with the result that the tubes being insulated cannot absorb the heat and the chimney temperature rises. The higher temperature causes the soot to fuse, thus further insulating the tubes and raising the temperature.

The possible loss due to soot is indicated by a recent test run at the plant of one of the largest electric light plants in the country. Figures from a new and perfectly clean horizontal water-tube boiler of 600 hp. capacity showed the uptake temperature to average 550 deg. on the first day and 650 deg. on the fifth. This increase of 100 deg. in only four days indicates an increased fuel consumption of about 5 per cent due to failure to blow the soot from the tubes. Service tests have indicated that boilers blown every 6 hr. show an increased efficiency of 4 to 5 per cent over those blown every 24 hr.

Tests made by A. W. Conklin, combustion engineer, showed the following temperatures:

	Near Bottom 1st Pass	Top 1st Pass	Bottom 2d Pass	Top 3d Pass
Hand blown	1697	954	727	618
Cleaned by steam blower	1691	934	649	527

Gas temperatures were read at the points indicated in a horizontal water-tube boiler. In the first case, the tube surface was blown thoroughly by a steam lance and the average temperature of the flue gas was 618 deg. In the second case, with the steam blower in use, the exit temperature was 527 deg., the difference in temperatures representing between 4 and 5 per cent gain.

The removal of soot by mechanical methods is a comparatively simple task provided a properly designed and installed soot blower is obtained. The elimination of water scale in the same boiler, however, is a much more complicated problem. This is due to the character of the substance as well as the location in the boiler in which it forms. This water scale is not only an excellent heat insulator, but is the cause of numerous, more or less serious, boiler failures. One of the large boiler insurance companies in New York reports that the large majority of their claims arise from burnt tubes due to scale incrustations.

These scale incrustations are due to the presence, in the feed water, of foreign material carried either in suspension (as clay and fine vegetable or organic matter) or in solution—as the carbonates, sulphates and chlorides of the various earth salts. The most common mineral substances so found are the carbonates and sulphates of calcium and magnesium although the chlorides of these salts are often present in lesser quantities.

This scale thrown out of suspension or solution in the boiler appears in three forms: (1) scum; (2) mud; (3) solid scale. The scum which floats on the surface of the water may, when first formed, be removed by means of the surface blowoff. If allowed to accumulate, it will finally sink and attach itself to the tubes or shell in the form of mud or scale. The mud is soft, very often in an almost liquid condition and may be blown out through the blowoff. If allowed to remain in the boiler, it may combine with the other scale forming material to form hard scale or may be baked to the boiler surface. The scale occurs as a stone-like deposit

*Abstract of paper read at the Fuel Economy Symposium held in connection with the National Exposition of Chemical Industries.

†District Sales Manager of The Roto Co.

ranging from a porous chalk-like substance, which is brittle and easily broken, to a dense cement-like stone which is often hard to break with a hammer.

Professor Schmidt, of the University of Illinois, from a series of tests with boiler tubes coated with scale of various thicknesses up to ⅛ in., draws the following conclusions: (1) Scale varying in thickness up to ⅛ in. causes a heat loss varying from insignificant amounts up to as much as 10 or 12 per cent. (2) The loss increases somewhat with the thickness of the scale. (3) The mechanical structure of the scale is of as much, or more, importance as the thickness, in producing this loss. (4) Chemical composition, except in so far as it affects the structure of the scale, has no direct influence on its heat transmitting qualities.

An example of the varying effect which scale may have on the conductivity of the boiler tube may be noted from the following table showing results of 16 tests made at the University of Illinois.

INFLUENCE OF SCALE ON HEAT TRANSMISSION

No.	Thickness of scale inches	Character of scale	Decrease in conductivity due to scale per cent
1	trace	Hard, dense	9.1
2	0.02	Hard	2.02
3	0.033	Soft	4.3
4	0.033	Very hard	3.5
5	0.033	Medium	4.03
6	0.04	Soft	6.82
7	0.04	Hard, dense	3.07
8	0.042	Very soft	9.54
9	0.047	Hard	2.75
10	0.065	Medium	2.39
11	0.07	Soft	2.38
12	0.07	Hard	4.43
13	0.085	Soft	19.0
14	0.089	Very soft	4.95
15	0.11	Hard	16.73
16	0.13	Hard, dense	6.75

While there is considerable range to the reduction of conductivity noted, any of the losses found, if reduced to the coal pile cost, would amply repay for the removal of the scale.

Tables have been prepared by various interested parties showing that 1/16 in. of scale will increase the fuel consumption 15 per cent, ¼ in. 60 per cent, etc. It will be seen from the foregoing remarks that this relation does not strictly hold. If the scale is hard and dense and practically waterproof, it will doubtless be an effective heat insulator; while if it is porous, as many scales are, the water will be able to permeate the scale and, reaching the boiler metal, transmit the heat with comparatively small fuel loss.

One-hundred-twenty tests made by the Illinois Central Railroad indicated an average increased efficiency due to thoroughly cleaned tubes of 11 per cent; while E. M. Fiske states that as a result of tests made for 3 mo. previous to and 3 mo. after scale was removed from a boiler, it was found that the result, at the coal pile, was 10 per cent in favor of the clean heating surface.

The Hartford Steam Boiler Inspection and Insurance Co. reports, as the result of one year's inspections, 157,804 boiler defects due to 22 causes. Of these, those due to deposits of scale or sediment numbered 41,026 or approximately 26 per cent.

Could these scale incrustations be eliminated from the fuel burning plants of the country, the saving effected in the national coal pile would be of staggering proportions and one of the direct results would be an appreciable price reduction to the consumer.

The ideal feed water would, of course, be one which was neither acid or alkaline and which contained no traces of the earth salts. Those waters, however, which do not contain scale forming material invariably carry material which will pit or corrode the tube. It is worthy of note that this action is far more serious than is the accumulation of scale. It cannot be easily detected and if not taken in time ultimately leads to ruptures in the boiler. The usual care for this type of boiler trouble is to add some scale forming material to the feed water—such as carbonate of soda.

While there are no theoretically perfect feed waters, various treatments have been developed with the idea of purifying the feed water so as to eliminate the scale incrustations.

MECHANICAL SCALE REMOVAL FROM THE BOILER

THERE IS every reason to believe that the large power plants and central stations have adopted the most modern and economical practice in this portion of their boiler room procedure. These people have staffs whose duty it is to develop the plant efficiency to its highest point.

It has been the speaker's experience that every one of these large central stations is using mechanical methods of scale removal. The advocates of internal chemical treatment argue that by allowing the scale to accumulate the efficiency of the boiler is gradually dropping until the boiler is again cleaned. Engineers of experience believe this method of handling is far more economical than to concentrate the feed water by the addition of impurities to those impurities already in the water.

The engineers of the Babcock & Wilcox Co. have made extensive and intensive study on the subject under discussion. Their conclusions are partially outlined in the following quotation from "Steam."

"It is necessary that in each individual plant there be a basis on which to judge the cleanliness of a boiler. It is, of course, impossible to keep boilers absolutely free from scale at all times but experience in each individual plant determines the limit to which scale can be allowed to form before tube difficulties will begin or a perceptible falling off in efficiency will take place. With such a limit of scale formation fixed, the operatives should be impressed with the danger of allowing it to be exceeded."

It will be readily appreciated from the foregoing, that the dense, hard scale will form the most rapidly in that portion of the tube surface which is subjected to the highest temperatures of the gases. This portion of the boiler is naturally found in the lower four or five rows of tubes in the first pass.

The practice of the large central stations consists of the frequent cleaning of these bottom rows together

with three or four of the upper rows at each time. In this way, the entire boiler is cleaned at least twice a year, while the lower rows are cleaned every 30 to 60 days.

It but remains to bring to your attention a few requisites in connection with mechanical cleaners. The cleaner should be so designed and constructed as to remove thoroughly all the scale, in the shortest possible time, at the lowest cost to operate and should require a minimum of expense to maintain and repair, working with absolute safety to the boiler and operator.

Without reviewing the history of tube cleaner development to the present high standard, I would call to your attention that three methods of driving mechanical cleaners present themselves, i.e., air, steam, and water. Where the plant is equipped with compressed air in sufficient quantities and pressure, the air driven cleaner is preferable. Failing in this steam may be used. The majority of plants have water at sufficient pressure, either from the feed or fire pumps, to enable them to operate a water driven machine if compressed air is not installed and the plant conditions prohibit the use of steam.

P. J. Darlington, a pioneer in the development of the air driven machine, although not now connected with the trade, designed a cleaner the action of which depends on the cutters being thrown out against the scale by centrifugal force. Inasmuch as centrifugal force depends directly on rotative speed, the interior of the machine is designed for high speed over long periods. In the cylinder a single steel blade at all times is subjected to the pressure medium. This blade is fitted to an eccentric cylinder bore which is necessarily out of round. The relation of the metals in blade and cylinder are as dictated by good engineering practice. A small portion of the blade's rotation utilizes the expansion of the pressure medium.

Straight-edged ports are provided for admission and exhaust giving clean, quick action. At the air inlet end where it is hard to supply lubrication, a roller bearing is furnished. The body of the motor is of bronze while hardened steel rings are provided where the motor slides against the tubes. This motor may be driven by steam pressure as well as air.

The water driven motor has its bearings in one long inner shell, held always in line and away from the great mass of water operating the machine. The nozzle plate located at the extreme outlet end of the motor directs the water to a turbine wheel which, being shrouded, compels the water to deliver all the work stored up in it, before it is discharged into the boiler tube. No back pressure being present, the maximum efficiency is obtained. The body is of light bronze construction with steel wearing rings.

The bodies of the motors are made as large as possible and still permit the cleaner to pass through the tube. In fact, so large are they that they act as tube gages and the passage of the cleaner through the boiler tube is an assurance that it is clean.

With both air and water driven cleaners a swing frame head is used, so designed that three sets of cutters are thrown out against the scale. The arrangement is such that these cutters are so designed as to eliminate sharp points scratching or damaging the tube. Other cutting heads are furnished to meet peculiar scale conditions, each so designed as properly to do its work without damaging the tube.

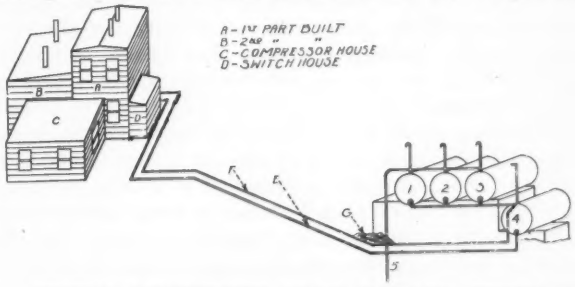
The conditions outlined as pertaining to boilers, likewise hold for fuel economizers, condensers, evaporators and other tubular and pan mechanisms used in the power plant and chemical industry. Mechanical cleaners, properly designed, may be obtained for each size and type mechanism which it is desired to clean.

Experiences in the Glendale Plant

WALLACE DESCRIBES TO BLAKE HIS EXPERIENCES WITH THEIR OIL-HANDLING SYSTEM AND SUGGESTS IMPROVEMENTS. BY G. H. KIMBALL

Bridgetown, March 25, 1911.

DEAR JOHN: After the big freeze that I wrote you about in my last letter, the company got busy and had every hole stopped up that was visible; then by adding more steam coils, it was possible to be quite comfortable in the plant by the middle of the day. Drains have been put in all of the cooling water pipes so we were able to start with some reliability after a while. In the mornings, the thermometer set about 5 ft. above the floor will register around 50 deg. but there is danger of some pipe in a remote place under the floor being stuck when a cold current of air blows upon it.



GENERAL ARRANGEMENT OF OIL HANDLING SYSTEM

The manner of getting our fuel has not been an unalloyed success for several reasons, some of which I will tell about here. At first they used to haul it in a small tank wagon which held enough to run one unit two and one-half days. After the second unit began to operate, it had to be filled too often so the new arrangement was devised.

I enclose a rough sketch of the general arrangement of the temporary power house with regard to the fuel storage tanks. These are located about 150 yd. away; the upper ones, 1, 2 and 3, receive the oil from the tank cars through the pipe, 5. Then from them the oil flows by gravity to the tank, 4. This holds about 7500 gal., but it is seldom filled to the top and it has been our custom to run some in every Sunday so that it will not have to be done during the week.

While the matter of forcing the oil to the plant by air had been discussed at some length, it took a long time to get any action. Finally the 2-in. pipe, E, was laid on top of the ground for the oil, then the 1-in. pipe F was laid the same way for the air which was taken from the first stage of the compressors. The pressure in this stage never exceeds 60 lb. and a relief valve was also placed on the line going to the tank which was set at 40 lb.

The tank was about 7 ft. in diameter, of 7/16-in. steel with lap joints and convex heads so that I thought that 60 lb. would not be excessive for it.

Pipe E came from the bottom of the tank and the pipe F ran into the top and the oil was forced up to the plant with dispatch. It took considerable pumping to fill the empty space with air when the oil was halfway down, but once full of air at 40 lb. pressure, it would answer for all day with very little drop in pressure. At the end of the week, the vent was opened, the air drawn off and the oil allowed to run in from the other tanks until it was nearly filled.

This worked fine until the freezing weather came, then somebody had thrown a pile of dirt, G, which covered the pipes at a point where there was a pocket in the air line. This had filled with water and frozen so that one morning we could get no air pressure in the oil tank, or I should say no increase in the pressure for there was some from the day before still in it. By this we were able to get oil enough to run with until a steam fitter could lay a new section of pipe around the frozen pile of dirt. This same trouble occurred at a point nearer the power house after that and it was remedied the same way.

After that we did not have much trouble with the air, but the oil would get very thick with the cold and some mornings it would seem as if the oil would never start even with 60 lb. pressure applied to the air line and when it commenced to flow, the stream would be about as large as a pencil, but it would soon grow larger as the thicker oil was forced out of the pipe. One morning, nothing would come after applying all the pressure that was safe to use and a hurry call for assistance was sent to the superintendent, who sent some men down at once and it was decided to apply a heavy pressure to the oil pipe and blow the congealed oil back into the tank. This was prevented by a check valve so the disc was removed and the oil blown out on the ground to that point, after which the cap was replaced and the pipe was cleared back to the tank. While this was being done, we all took a hand in carrying oil in pails in the bitter cold wind; we managed to keep the unit running until the oil was coming again.

When the new plant is completed, I hope to see these pipes buried below the frost line and instead of using air, have a small triplex power pump located in a weather-proof shelter at the base of the tank so that the oil would run to it by gravity. The motor for this need not be over one horsepower, as there is no pressure to pump against and it could be started by simply throwing in a switch in the engine room and if the oil was thick, the pressure behind it would force it through the pipe without putting any pressure on the large tank as the air would do.

We have a man here by the name of Edward Gillis who seems to be a very good all-around mechanic and he is interested in your place up there. He has done considerable work for us on the engines and should be well qualified to handle them if he puts his mind to it. I am going to write to your manager Wilbur about him so he may come up to see you soon.

I hope to hear from you soon so until then, I am,

Your friend,

WILLIAM WALLACE.

Keeping Power Plant Operating Costs

DEFINITE UNIT COSTS MAY BE BEST ASCERTAINED BY MEANS OF AN ACCURATELY KEPT LOG. BY ALLEN F. BREWER

THE SUBJECT of operating costs as related to power plant accounting has been treated in many discussions, bearing on the manner in which they should be recorded. Opinions of engineers and managers differ widely as to the extent to which such, as relating to daily records should be carried on the books. It is a broad, important subject and worthy of all the consideration which it receives. The following ideas are offered, based on the author's experience with marine and stationary power plants burning both coal and fuel oil.

To many operating engineers, the engine-room and fire-room log is a nemesis. They appear to see little value in its records and consequently take little care in making it out. Yet, such a log, accurately kept and properly filled out, is a most valuable accessory to the managing engineer or accountant who desires to ascertain definite costs of operation. In fact, the log and the account books may be worked hand in hand to a surprising extent.

Let us consider the basic constituents which go to make up a power plant operating account. Such would cover the costs of actually running the plant to carry on the daily work required to generate the desired power, be it electricity or steam. In order to arrive at the foregoing, coal or fuel oil must be burned and water fed to the boilers to be transformed into steam; also in the engine-room oil must be used for lubricating purposes and waste for cleaning. These are the primary materials which must be accounted for. Then there is the cost of labor. Assuming that the plant is running under three shifts of 8 hr. each, we might probably require two men in the fire-room, an oiler in the engine-room, and an assistant engineer in charge for each watch.

The daily payroll would thus include, for a normal plant:

One chief engineer.
Two assistant engineers.
Three oilers.
Six firemen.

Now let us return to the cost of materials. We will say that entries on the books indicate as follows:

Weight of coal, or gallons of fuel oil.
Gallons of water.
Gallons of lubricating oil.
Pounds of waste.

It is most essential that the above-mentioned materials be measured, to keep proper record of consumption, and, therefore, material costs to operate. If firing coal, such should be weighed before firing and noted in the fire-room log. It is not fair to assume that because we have bought 100 tons of coal that all this is fired, owing to waste, depreciation and oxidation. Or, if the plant burns fuel oil, all such oil should be passed through a meter before being led to the burners. Waste with fuel oil is far less than with coal, yet, leakage may at times result in an appreciable loss. Such oil meter readings should be taken hourly and recorded in the log. The

same argument applies to water used as boiler feed. All water used should be metered and recorded hourly.

Then, we should consider mode of using lubricating oils. All such oils should be stored in fire-proof cans, outside of the fire-room, and the oil drawn off in suitable measures as required; no more or less. It is surprising to what extent lubricating oil will be wasted simply by careless handling and sloppy usage. The number of quarts of lubricating oils should be recorded in the engine-room log at the end of each shift or watch. Waste is a seemingly small item, yet it is bought by weight; therefore, the length of time required properly to use 100 lb. can be ascertained by trial, and an approximate allowance thereby issued per day for general clean-up work.

Thus, by following out the foregoing plan of measuring all materials used, with little additional work we have at hand an hourly and daily record of materials used, and their cost to run the plant. In fact, we are running a continual plant test in basic form. The daily costs might be tabulated roughly as follows:

Item	Unit	Amounts used per day	Unit cost	Cost per day
Coal	Tons	.....	.....	.....
Fuel oil	Gallons	.....	.....	.....
Lpb. oil	Gallons	.....	.....	.....
Waste	Pounds	.....	.....	.....
Water	Gallons	.....	.....	.....

On the books should be entered daily entries as above, and also the corresponding labor costs for operation. With such data at hand, the engineer or superintendent can tell at a glance the unit cost of his power delivered for any particular day or fraction thereof; what his normal demands are; and the cost to meet peak loads for the length of time that such occur.

The Engineer's Opportunity

NECESSITY OF EDUCATING PLANT OWNERS OF VITAL IMPORTANCE IN OBTAINING ECONOMICAL POWER PLANT OPERATION. BY H. A. CRANFORD

NO radical changes are ever made until somebody has gone to the trouble to educate those employers or people who are to be affected by the change. And the job of educating those to be benefited is generally a pretty big proposition for the educator. The history of all reforms, changes, betterment of conditions, etc., is that somebody conceives an idea far in advance of his time, as we express it. When the idea is advanced, people pay very little attention; the originator becomes discouraged, and finally gives up the fight.

In time, somebody else takes up the idea and pushes it along and then another, each adding to it, until finally some condition, crisis, or circumstance arises that brings the people to see the great necessity of the idea that the originator of it advanced several years back, and then everybody runs over the other fellow trying to rush it into effect, with the result that the thing is often overdone, and to gain the benefits of the plan, much temporary waste takes effect.

The present situation, in regard to power plant supplies—coal, oil, and labor, causes me to make the foregoing remarks. I remember that back in 1898, I was burning slack coal in my furnaces that cost us 40c a ton at the mine, with 60c a ton freight rate. The cost of unloading was $2 a car. At the time, the boilers had no insulation over the tops. Steam pipes were not covered. We had no heater, but used a Penberthy injector. Flues were sometimes blown daily, sometimes not so often. Common hemp was used for packing.

I was just out of my apprenticeship at the time, and was very ambitious. When I took charge of this plant, I knew that we were spending at least twice as much as we should to operate it. I called the boss in and talked with him about the conditions. I was given very little consideration. He told me that the plant was making money and as long as it did the city authorities would not listen to me; that with coal as cheap as sand, we should not worry about what we wasted. I used the argument that it would not only pay a big dividend in cold cash to improve things, but would make it a much better job for the employes. He replied that he could hire a train-load of men for a dollar a day, and if there was anyone that didn't like his job a dozen competent men were waiting for his place. I took the matter personally and let one of them take my place.

Things rocked along all these years in that plant, with the result that twice they had to replace their machinery with new. Until about 2 yr. ago, the highest salary they had ever paid was $100 a month for engineers. At last the time came when fuel instead of costing around $1 a ton, cost about ten times as much. Everything else in proportion. Labor could not be found. The result is that this plant had to buy all this new equipment at a price from 50 to 300 per cent higher than it would have cost in those other years, besides having lost thousands of dollars annually for the want of this identical equipment. Their employes take very little actual interest in the plant even now because good men do not care for the job, and the other kind remarked to me that it was a good job now, but "it would never have been if the bosses could have gotten by without it."

When I left that job I resolved to myself that if I followed engineering I was going to run my department my way. That "my way" every time would be the way I *knew* was best after studying the matter from every possible angle, from the owner's side, first, and my personal side, second; and that when I ran up against a proposition that, to follow his interests, would conflict with my or my family's interest, I would give him the exact dope on the situation and let him get another man. I have never had to quit a job yet on that account.

Pretty early in the game, I discovered something that has been very valuable, that if you are to succeed in looking at the owner's side of it, you must have an education something like his; must be able to talk his language. Use illustrations that he is familiar with, think as he thinks, arrive at conclusions after the same method that he uses.

My education had been limited to the common schools of my time. Force of circumstances had kept me from

completing the full course. To be able to do what I wanted to do, I must improve my education. I decided to take a correspondence course in bookkeeping and commercial law. I completed that course and the lessons that I learned there have carried me through many a stormy argument with the boss when I was trying to put through some needed improvement. While taking this course, I formed a habit of study that has remained, and the result has been that I have gained information that has been invaluable to me as well as the employer.

Now the time has arrived in our business when we must conserve the natural resources of our country. Recently engineers have talked with me quite a lot on this subject. Practically all of them have places in their plant where they could reduce operating costs; but they are not doing it. They give various reasons for their apathy in the matter. One of them showed me what he wanted to do in his plant and said that every time he mentioned it to the boss, the boss out-talked him.

Another one wanted to tear out an old engine and install a modern one in its place. His boss told him that he would not hear of it.

Another said that his boss lived out of the city and left the plant entirely in his charge; that he had not seen his boss in 12 mo. although he had tried every way he knew to get him to come in and pass on some changes. There were other reasons given, but I want to offer the advice to engineers that I offered to these friends, as they actually cover some conditions that I have been up against.

In the first place, when I am right about a thing and know what I am talking about, I don't believe any boss can out-talk me, for I have studied over the matter before I mention it to him, and generally have him at a disadvantage. In our first conversation, I make mental note of his points of objection, and prepare for him on his own ground for the next conversation. I enjoy a battle of wits. The conditions with the second man were that if he had gone to the trouble to look into the matter from the boss's interests, put himself in the boss's place so to speak, he would never have wanted a new outfit, but have asked to be allowed to make some repairs in the old unit. He damaged his standing as a man of sound judgment when he insisted on a new outfit.

The third man had the chance of a lifetime. The very fact that his boss left matters with him, let him buy what he wanted and write his checks, proved that his boss believed that he had a man who would use his judgment in his interests. The things that this man wanted to do would have increased the earnings of that particular plant at least 15 per cent, which would have repaid the owner in less than 12 mo. He simply didn't have the backbone to back his judgment. And that is the trouble with a lot of us, wishbones where we should have backbone. If I had been in his place, I'll bet the boss would have come to town without my ever writing again.

I have in mind a plant where the engineer in charge had been with the plant over 20 yr. He resigned and to the man who succeeded him, he gave the reason that they would not allow him to spend anything on the plant, and it was going down. The new man took charge. The owners kept him under a microscope almost, because he started in to spend money. The new man, knowing the reason the other man quit, decided to go right after things from the start and consult nobody. He would wait for them to yell. After a while they yelled all right, but what he had already accomplished was showing results that they could not deny. He won that time and kept spending money. They would yell again every now and then and call him in and show him the former engineer's monthly operating costs. He would show the results he was getting in words they could understand. He would go back to the engine room and spend more money. They were not asked to buy new machinery, or any new equipment, but he paid attention to every detail. It was a great battle, but today he draws exactly 100 per cent more salary than the former engineer drew.

The help all get 100 per cent more than the old crew. Fuel is 125 per cent higher and all other items have advanced in proportion. The load has increased 104 per cent on the plant, yet last month's operating expense was exactly what the corresponding month was in 1918 when the present engineer took charge.

All of this brings me back to the beginning. The average employer knows very little about the engine room because he has never been educated to it and it's up to the engineer to be the educator; but remember that before the missionaries ever accomplished much in heathen lands, they had to learn to talk to the heathen in their own language; then go to them with a proposition that could not be disproven, believe absolutely in what they were teaching, and illustrate the truth of it with illustration with which the students were acquainted, as well as point to actual results that had been accomplished elsewhere.

I make it a point never to ask for the thing that is not needed, but when I do ask for it never quit asking for it till I get it, and find that every time I make good on some proposed change it is a little easier to get the next proposition through.

The engineers of this country can be its best and greatest benefactors, if they will get busy to go about educating the plant owners not only to the necessity, for they already realize that, but the possibility of conserving materials such as fuel and doing it in a way that will be profitable to the owners. The future of our trade looms great with possibilities, and it is up to us as intelligent, thinking business men to make good and reap the benefit that will accrue to us.

PEAT CONSUMED in a properly lined gas producer yields gas of good quality and in abundant quantity in comparison with the yield of coal and also many valuable by-products. This is perhaps the most effective utilization of peat fuel for generating heat and power, because peat that is to be used in this way does not need to be so carefully prepared nor so thoroughly dried as peat that is to be consumed for domestic purposes or under steam boilers. Gas producing plants using peat fuel are operated in England, Ireland, Germany, Sweden, Italy, and Russia, but in the United States, although experiments have been made, no gas-producing plants are operated with peat.—The Gas Engine.

Automatic Lubrication

How the Demands of Machinery for Pumping Oils to Bearings Have Been Met. By A. H. Noyes

THIS IS truly the age of machinery. The mechanical inventions of the past 50 yr. have been so marvelous as to be almost unbelievable. Watching one of the modern machines, with its giant arms, manipulating with absolute ease seemingly impossible loads, and another one performing operations delicate enough for a woman's fingers, it is almost impossible not to look for the god, sometimes the demon, who must be hiding behind the thing and working the levers.

But did you ever stop to think that all this mighty, intricate, and often delicate, machinery depends absolutely upon one tiny, insignificant thing, a thing that cannot only stop every current and still every cog and every wheel but damage the whole apparatus beyond repair? Does one person in a thousand realize that this tiny thing, which nevertheless, has the life of the whole tremendous mass of machinery in its power, is a drop of oil?

This seemingly unimportant thing becomes of prime importance, and must be considered from two view points. The first of these is the selection of the lubricant, and the second is the continuous application of this lubricant to the bearings, in the amount required.

Only a child would attempt to lubricate the highly polished bearings of an astronomical instrument with graphite, or to put crude oil in the delicate movements of a watch, neither would highly refined machine oil be of great service in the bearing of a cement crusher. But between these wide limits there is an infinite number of degrees of refinement, and much of the life of a machine depends upon the selection of exactly the right lubricant.

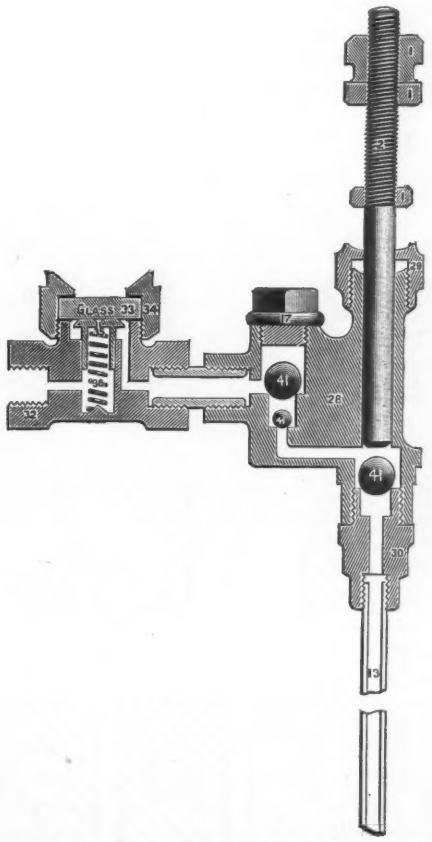
The utmost care and the most expert knowledge might, however, be exercised in selecting just the lubricant suited for a machine, and little use would it be if it never reached the bearings; a poor lubricant that reaches the spot is much better than a perfect one that stays in the oil tank.

This is where the element of human frailty formerly entered. Some accurate and reliable lubricating instrument had, therefore, to be devised. There were, however, certain advantages that the human oiler did have; the machine which should replace him must incorporate all of these advantages to a higher degree, and in addition, it must not get out of order. So came into existence the force feed lubricator.

For instance, the lubricator must start work as soon as the machine starts and must deliver oil in proportion to its needs. A ratchet driven pump was found to fulfill these two conditions. It derives its power from a moving part of the machine and consequently stops and starts, and accelerates or retards its own speed, exactly with the machine. It therefore regulates its delivery in direct proportion to the needs of the machine.

Some of the pumps are fitted with worm gears. These are especially adapted to high speed steam units, such as direct connected lighting engines, and sawmill steam feeds of the reversible rotary type. But the "man with the oil can" was not affected by heat or cold, and, if working in flying dust, he might rub his inflamed eyes, but he still kept on oiling. The best modern force feed lubricators have heaters incorporated in them, and they are more oblivious to cold than any man. They do not solidify in winter, therefore, and they do not overfeed in summer.

The only way to avoid dust clogging was to place the oil in a solid box free from the working parts. This principle, as soon as discovered, was applied in the most advanced type of pumps. In this way, it was made absolutely impossible for flying dust and grit to get into the oil and be carried to the bearings.



CROSS SECTION OF PUMP WITH ONE-PIECE VALVE

The working parts should be simple as possible and they must be easily reached and repaired. One model has a one-piece valve which eliminates practically all troubles, for it is obviously impossible for a solid casting to get out of order. All the working parts of this model are on the outside of the oil reservoir.

The sight feed is one of the latest and most important devices added to the force feed lubricators. This sight feed leaves the action of the lubricator visible, so that an interruption in the flow of the oil is immediately detected. By its means, also, the engineer can see exactly the quantity of oil going to the various bearings.

The lubricators also have several chambers in the oil reservoirs, as many as required, in fact, and can therefore deliver different oils to different bearings. This is necessary to the life of any machine. Pumps of all sizes are in use, from the very small, one-feed pump, to the one holding several gallons of oil and delivering by 40 feeds. The larger pumps, or, as they may be called, pump systems, are designed for the location they are to occupy.

The lubrication of an entire plant is thus controlled from a central point. The economic advantage of such a system is unquestionable. To such an extent is this recognized that practically all the large power plants and all marine engines are equipped with the automatic force feed pumps.

Although accuracy and reliability of action were probably the chief considerations in the mind of the originators of these pumps, yet they have been found to effect a very great economy in oil, as well as in man power. Some of the pumps are credited with saving from 50 to 80 per cent of oil.

Doubtless recent years have produced more marvelous and more intricate machines than the force feed lubricator, but none have demonstrated a greater usefulness or a more perfect adaptation to the needs they were designed to serve.

Soldering Iron and Steel

By F. H. Sweet

WHEN IRON, steel and galvanized steel are to be soldered, the operation must be performed somewhat differently from that employed in soldering bright tin, brass or copper and most other "soft" metals except aluminum. The engineer had best not trouble with aluminum. The process of soldering is such a hard one as to be almost beyond his skill. But the soldering of iron and steel and galvanized iron and steel may be accomplished without difficulty of any kind with the same tools that are used for soldering tin.

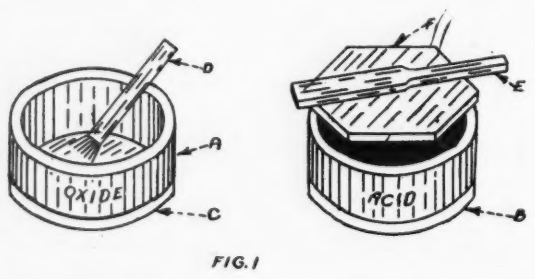


FIG. 1

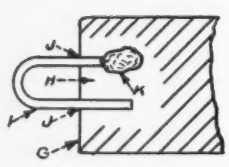


FIG. 2

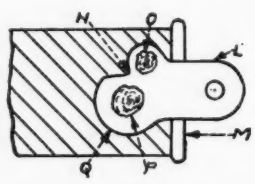


FIG. 3

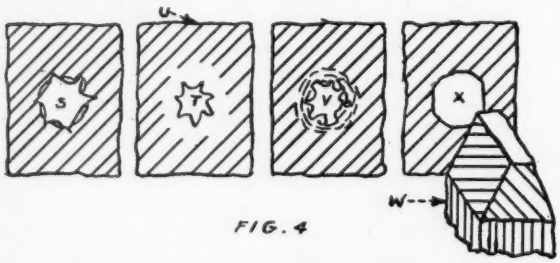


FIG. 4

FIG. 1. LEAD VESSELS FOR OXIDE AND ACID
FIG. 2. WIRE LOOP SOLDERED TO STEEL PLATE
FIG. 3. EAR SOLDERED ON GALVANIZED WATER BUCKET
FIG. 4. HOLE FILLED WITH SOLDER WITHOUT PATCH

A different flux is necessary for soldering the metals mentioned. Resin alone will not answer, though resin may be used to advantage with the flux required for this work. For soldering iron and steel, some zinc hydrochloric will be required. This substance is also known as muriate of zinc.

To prepare this solution, procure some muriatic (hydrochloric) acid, place it in a suitable vessel and drop in all the zinc the acid will dissolve.

Plumbers frequently use little lead vessels for holding the "oxide" and raw "acid," both of which are necessary when soldering galvanized steel or iron. The little lead vessels may easily be made, as shown in Fig. 1. Two pieces of lead pipe an inch long or more may be sawed from pipe 2 in. in diameter. Such pieces are shown at A and B, with lead bottom C soldered in place. These little lead cups may be marked by scratching on them with an awl or a knife the words "Oxide" and "Acid," as shown. The "oxide" is the acid in which zinc has been dissolved. The "acid" is plain, raw muriatic or, as it should be called, hydrochloric acid.

For applying the liquids on the metals to be soldered, plumbers frequently use little brushes, as shown at D, some bristles being caught between the sides or edges of a strip of turned-over tin. Or a little wooden paddle may be used instead of a brush. Such a tool is shown at E. It may be whittled from a bit of soft wood—white pine is best. Sheet lead covers should be provided for each vessel to keep out dust and to prevent evaporation when the fluids are not in use. These covers are plain bits of sheet lead, one of which is shown at F.

The oxide dish, A, is very handy when using a copper continuously. A quick dip of the soldering bit into the oxide cup will restore the solder coating on the bit in a most remarkable manner. The same thing can be done with the can of soldering paste with which the solderer may have provided himself.

To solder pieces of iron or steel together, say as shown in Fig. 2, where a hang-up loop I is to be soldered to a bit of steel plate, G, cut off the required length of iron wire and brighten the ends which are to be soldered. Also brighten the portion of the steel plate to which the loop is to be attached. Make a good job of the brightening. No half-way brightening will answer. The surface must be clean.

Brush over the brightened surfaces with liquid from the oxide, then apply the heated soldering bit, with as

much solder as the bit will take up. Wire I may be laid upon the can cover during the tinning operation—the same can cover that is used for coating the copper bit with solder. Rub the wire with the hot copper, right down into the melted solder on the can cover, using plenty of oxide, and almost immediately the clean wire will be found well coated with solder, as shown at J, J.

Next treat the plate, G, with oxide and solder and coat round where the loop is to be attached, as shown at H. A little resin added to the oxide on the plate will cause the solder to flow well over the plate. Next place loop I in position. Hold it in position with the end of a file or with a screwdriver and apply the heated, solder-charged copper close beside one leg of the wire, lengthwise to it, and the solder will flow all along the wire and over it, if solder enough be used, presenting the appearance shown at K.

With the copper properly heated and the surfaces well cleaned, there will scarcely be a line or lump to be seen in the solder job, K; but if any of these things be neglected, then you simply can't make a good clean job of it, try as hard as you may. Thus far the raw acid has not been used. Only when galvanized metal is to be soldered will raw acid be necessary. Such a job may come up in the mending of a water tank or the gasoline tank of an automobile. Figure 3 shows a job very likely to come along—the soldering of an "ear" to a galvanized water bucket.

The ear, L, may be new, to replace a broken one. It has probably been cut from a stout piece of galvanized steel, shaped properly, and is to be fastened to bucket N, as shown. The beginner would most likely lay the ear in position and proceed to waste good time and solder in an attempt to fasten it in place. But we will not start that way. First, the ear must be well riveted by two rivets, one of which is shown at O, through the body of the ear N.

Riveting is absolutely necessary, for the reason that the soldering of galvanized metals can never be depended upon for strength. It will do for securing tightness, but the parts must always be riveted or locked together to obtain the necessary holding strength. For this purpose, the two rivets are used in ear L N.

After the ear has been well riveted, apply the raw acid liberally. This brightens the parts so that no scraping is necessary. It also removes any rust or oxide from the ungalvanized rivets and edges of the ear and also coats the part with zinc oxide, formed by the action of the raw acid upon the zinc coating of the galvanized metal. Then solder is applied over and round the ear L, and flows under and round it, leaving a smooth solder surface, as shown at Q. The top of the rivet is also treated and becomes smooth and solder covered, as shown at R. Later the rivet O and end of ear N are treated in like manner. Thus the acid is changed into "oxide" during the operation and coats the steel with a film of zinc so the solder can adhere to it. The copper should be somewhat hotter for soldering galvanized metal than for use on tin.

Figure 4 shows how a large hole either in tin or galvanized metal may be closed with solder without using a patch. The hole, S, was made by some object which turned inward on the edges of the plate. At T the edges are shown hammered back flat and well brightened as far back as U. If tin, resin and "oxide" are used and solder is piled round the hole, as shown at V. If the metal be galvanized, then raw acid is used.

To close the hole, as shown at X, the soldering bit, W, is heated only barely hot enough to melt the solder shown at V; then the tool is applied, as shown at W, and moved sidewise with a quick, even movement. The solder is "pulled" right over the hole, closing it completely. But this cannot be done if the copper be either too hot or too cold. For this and other kinds of heavy work, a form of bit known as the "hatchet copper" is preferable. This tool is also a vital necessity for soldering lead pipe and long seams in heavy metal. It holds its heat better than does the pointed copper.

The keynote of success in all soldering operations is "keep the soldering bit well tinned"—to which may well be added—"and the work well cleaned."

Refractory Cement

ABOUT THE power plant, the boiler furnace is probably the most difficult construction to keep in working condition. Engineers will therefore welcome the following suggestions made by F. W. Riesman at the Fuel Economy Symposium held in connection with the National Exposition of Chemical Industries.

Laying fire-brick for furnaces practically in brick to brick joints is advocated, buttering them with a thin batter made of one part water and six parts of the plastic high temperature cement. After the setting is laid, it is well to wash over the entire face of the lining with two coats of diluted cement; the first coat being of a consistency like whitewash (very thin) and the second coat applied immediately after the first, with a consistency nearly the same as used in laying the brick. This insures an airtight wall.

There is one important point in keeping the cost of maintenance of fire walls in boiler settings to a minimum, and that is, by patching the setting.

By the use of high temperature cement as a bond, a ganister can be made by adding crushed fire brick, a gritty, sharp beach or river sand, the best results being obtained by adding carbosand and plastering over the entire walls. In one of the largest central station plants in the East, they decided to transfer a battery of their boilers to oil. The stokers were left intact and the grate bars covered over with fire-brick. When the installation was complete, proper combustion was not obtained with the result that the tubes were blown and the setting had the appearance as if a gatling gun had been on the scene, as the entire surface of the brick work was virtually riddled full of holes. This ganister made of carbosand and high temperature cement was used which has the advantage of air setting, but when subjected to heat becomes harder than the brick itself and through the length of life obtained by the patching this particular station has since found advantages in similar applications where the work has been subject to abrasive action and thus have been able to lengthen still further the life of the setting.

"SATISFACTION isn't always gained by figuring in dollars and cents. The price usually is secondary when personal desire is gratified."

Packing Service Records

IT IS interesting to note that some care is being taken in the matter of incidental costs in the power plant. Instance is taken of a record sheet, devised by a manufacturer of packings and gaskets, to point out the comparative reliability, length of life and cost of different varieties and forms of packings. The log form, shown herewith, is to be filled out by the engineer of a plant when he installs new packing, gaskets, etc. Entry is made on that same sheet when this particular packing needs replacing. He can thus come to a realization of the service a particular material will give under such conditions and will be able ultimately to choose the best product for his needs.

In this log appear the headings "Plant No. of Unit" and "Location" under which the exact location of the gland under consideration including position on the machine and description or identification of the unit are listed. Under "Kind of Service" should be stated the kind of fluid handled, steam, saturated or superheated, gas, air, water, ammonia, oil, or acid and the kind and

STATISTICAL DATA AND PACKINGS SERVICE RECORD

Name of Plant _____ Superintendent _____

Location _____

City _____ State _____ Engineer _____

Plant No. of Unit	Location	Kind of Service	Pressures		Temperatures		Style, Name or Number of Packing	Spiral Coil or Ring	Sizes or Dimensions	Weight or No. of Rings	Gaskets	
											No.	Sizes or Dimensions	Material

SERVICE RECORD OF PACKINGS

Plant No. of Unit	Weight of Packing	Date Installed	Date Replaced	Pounds Hours Service	Weight of Packing	Date Installed	Date Replaced	Pounds Hours Service	Weight of Packing	Date Installed	Date Replaced	Pounds Hours Service	Weight of Packing	Date Installed	Date Replaced	Pounds Hours Service

BLANK RECORD FOR COMPARING THE SERVICE OF VARIOUS KINDS OF PACKING

condition of the rod or shaft served. Under "Pounds Hours Service" is recorded the length of service per pound of packing or the pounds of packing per hour of service. It is a purely comparative figure and can be used only in comparing different packing in the same kind of gland on practically the same service.

Much has been done in the way of recording fuel wastes, steam wastes, labor wastes, etc., where the financial loss is evident, but these little incidental costs of maintenance have not been given their due. More money can be wasted through the agency of these items than is commonly realized.

Large Circuit Breaker for Hellgate Station

THE heaviest circuit-breakers ever designed for 13,200-v. service will be installed by the United Electric Light & Power Co., New York, in its Hellgate station. There will be 120 of these solenoid-operated Type O4 circuit-breakers having an interrupting ability of 58,000 amp. at the arc (1,500,000 kv.a.). The disconnecting switches are gang operated and their operating mechanisms are interlocked with the oil-breaker mechanism so that the disconnects cannot be moved unless the breaker is not in operating position, thus assuring safety to operators.

These oil-breakers are unique in that the phase elements will be in separate rooms approximately 30 ft. apart, with the operating mechanism on the floor above, thereby preventing the possibility of a bus bar short circuit and minimizing the effects of a ground.

Study Men

SOME MEN have within them that which always spurs them on, while some need artificial initiative, outside encouragement.

Some men exert themselves under stern discipline; some respond only to a gentle rein.

Some men need driving; some coaxing. Some need the spur; some the sugar lump.

Some men do their best with work piled shoulder high; some men must have it given them a piece at a time.

Some men thrive on discouragement; some cannot work without cheerfulness.

Study men—the men over you, under you, around you.

Study them and learn how to get from each the best that is in him.—The Chair Man.

An Ideal Gas Plant

SPEAKING before the Kiwanis Club in Denver, Colo., General Superintendent T. O. Kennedy, of the Denver Gas and Electric Co., told them that in 1871 the first gas plant of Denver was erected, and even to this day, 50 yr. later, there has never been a moment that a customer was without gas, as far as the plant proper was concerned.

That is, without doubt, an enviable record, bespeaks efficient management, and incidentally lauds Colorado's coal supply. J. B. DILLON.

Thrift in Coal*

By George Otis Smith, Director U. S. Geological Survey

EVEN THE optimist needs to keep books. America's leadership in production and her unparalleled position in wealth of raw materials do not obviate the necessity that she should occasionally take account of stock; on the contrary, the very variety and abundance of our natural resources make a careful inventory more essential to a business-like administration of our estate than if the United States were a smaller country with only a few resources in moderate quantity. With nations, as with men, wealth is no excuse for waste, and thrift should be regarded as a national as well as a personal virtue.

Coal is the shortest word we have to express industrial power and domestic comfort. Even the rumor of a coal shortage simply demonstrates that this fuel is in reality the staff of life to the industrial world, and the temporary stoppage of any of the larger sources of supply threatens a nation-wide crisis. Shut down our coal mines, and the country becomes not only cold but idle and hungry.

The figures of our total coal resources, millions of millions of tons, or even the few hundred million tons of our annual output, are too large to be grasped, and it becomes necessary to express the facts in smaller quantities. Roughly speaking, 1000 tons of coal is what a mine worker mines in a year—the measure of what he contributes to the world's work and well-being. This human measure of 1000 tons also has the advantage of being easily visualized as a short train load (20 cars) of coal on its way to serve the varied needs of the consumer, and in our brief review of the subject we may well first note what are these needs—the principal uses of coal, among which this unit of 1000 tons is divided. Broadly stated, the largest use of coal is in furnishing motive power and heat for our industries and public utilities, 350 tons out of every 1000 tons mined going to the boiler house of factory, mill, shop or power plant. But next to these seven carloads of coal distributed throughout the country are five cars, or 250 tons of coal, which the railroads need for their own use. The domestic demand for coal comes next, 165 tons out of each 1000 tons of anthracite and bituminous coal being used in the homes of the land for heating and cooking. The coke ovens require nearly as much as the homes, or 130 tons; and the balance of our miner's contribution includes the coal for export and bunker use, 60 tons; the 35 tons of coal used in operating the coal mines themselves, which of course does not make up a part of our train load; and the 10 tons that goes to the gas works.

Even in this simple analysis of the use of coal, it would be difficult to establish any rigid scheme of priorities; we absolutely need coal for each of these uses, and this nation-wide dependence upon coal is so evident as to demand general attention to the subject of thrift in coal. Every citizen should do his part in making the best use of coal, but the responsibility of leadership in economy may with justice be placed upon the larger users—a priority of duty that I believe will appeal to your sense of fitness.

We are on the threshold of fuel economy. Unprecedented high prices for coal have summoned American genius to the task of getting the full value out of the half billion tons of bituminous coal we burn each year; indeed, we have been too long content simply to burn coal rather than to use it. With coal at a dollar a ton the consumer was the profiteer, and profiteer-like he thought it paid him to disregard any claims except those of his own immediate gain. Now the higher prices have opened our eyes to higher values in coal, and we begin to see the possibilities of profit in avoiding waste both in the mine and in the boiler room. We do not have to recognize the claims of posterity for coal conservation, for we can see money in it for our own generation—to mine the coal that we have been leaving underground, to utilize every possible heat unit in what we burn, and especially to recover everything of value that the coal contains.

When we indorse Mr. Hoover's characterization of the bituminous coal industry as "the most functioning industry in the country," it is with no spirit of unfriendly criticism. The simple fact must be faced that the story of coal is a story of waste, all the way from the face of the mine working to the smokestacks of the boiler plant—waste of a natural resource, waste of human endeavor, waste of capital, waste of transportation capacity, and waste of energy—and of none of these have we enough, much less any to spare.

No sooner does a ton reach the surface than 44 lb. of it is taken as toll for running the mine. It is wholly conservative to figure that 50 per cent of coal now used in mine operation can be saved by simply extending electrification from central stations, even though this carrying of power to the mine mouth might seem illogical.

Another measure of coal waste in the generation of power, even where the conditions promoting efficiency are much more favorable, is afforded by the records of the public-utility plants of Massachusetts. During the month of June last the average coal consumption in all these plants was 2.29 lb. per kilowatt-hour, but at the largest plant of the largest company the average was 1.8 lb.—a saving in coal of more than 20 per cent, representing the difference between best practice and average practice.

How to save coal on a country-wide scale is the question. O. P. Hood, of the Bureau of Mines, has made the point that in a boiler plant construction, operation, and fuel are to a certain extent interchangeable. Skillful planning and careful operation can take the place of part of the coal; and on the other hand, cheap coal has made possible careless firing of poorly constructed boilers without the wastefulness of the whole procedure being apparent on the books. Waste that can be seen only as a theoretical proposition does not appeal with the same force as waste that writes itself in red figures; and now that coal is no longer as cheap as dirt, but has taken on the dignity that comes with high prices, we

* Abstract of paper presented before the American Iron and Steel Institute.

naturally begin to think of careful use. Thus the opportunity has arrived for the fuel engineer to teach us thrift in coal.

With all the marvelous record of industrial progress in the United States, we have good reason to ask ourselves if our knowledge isn't far ahead of our practice. As a matter of plain fact, to make great advances in coal saving it is not necessary to adopt untried theories in winning larger values from the coal we use; the first step is simply to lift average practice up to the level of the best practice. Even if the law of the survival of the fittest, under the present somewhat more humane rules of public regulation, does not today have full force in economic evolution, it remains of utmost importance to the world that industry should feel the pull of its most progressive units. Take, for example, the possible coal saving by the Massachusetts public utilities if their average efficiency should be raised not to a theoretical standard of fuel economy, but only to the standard achieved in actual practice by the largest company, which I have just cited, the result would be nearly a third of a million tons less coal needed each year by these plants—an appreciable relief in a single state, especially in a state where, as you know, it is so difficult to keep the stocks of steam fuel up to a safe level.

Still more striking is the evidence that can be brought forward to show the coal saving possible through the larger use of electricity as the agency in applying the energy in coal to the aid of human labor.

It is cause for general satisfaction that in the first half of 1920 we find the power output of the central stations of the country increased more than 16 per cent over that of the corresponding period last year, while the fuel used seems to have increased not over half that percentage. In these public-utility plants, the trend is decidedly toward fuel economy.

Belt Creep

By W. F. Schaphorst

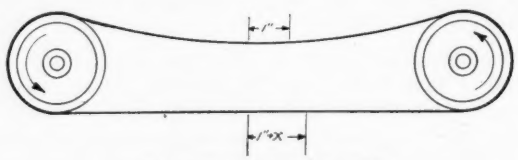
IN the first place, a belt creeps because it is elastic. Since all materials are more or less elastic, all belts creep. Even belts made of steel are bound to creep, because steel also is elastic. The more elastic the material of which the belting is made, the greater the creep. By means of the illustration herewith, I will endeavor to explain why a belt creeps.

On the upper or slack side, let us take a portion of the belt 1 in. long as indicated. This 1 in. moves toward the left as the belt runs around the pulleys. As soon as it comes in contact with the driven pulley, it is acted upon by a slight force due to the tension created by the driver pulley. As this 1-in. portion moves downward, the pull becomes greater and greater and when it leaves the driven pulley at the bottom, the pull or tension has attained its maximum value. Instead of being 1 in. long, however, its length has been increased by the value "x." Just what this amount "x" is, depends upon the material—the elasticity of the material and the intensity of the pull on the tight side.

It is this gradual readjustment from a length of 1 in. to a length of 1 in. + x that causes the belt to "creep." Hence we have a shortened belt running onto the driven pulley and a lengthened belt running onto the driver pulley. On thinking it over, it becomes evident that it is impossible for such a condition to exist without a readjustment somewhere and that readjustment occurs in the form of creep.

Power is lost, due to creep, for the same reason that power is lost, due to any friction; that is, wherever there is friction, there is power loss. The amount of power loss is easily determined when the percentage of creep is known. For example, if the creep is 1 per cent, the power lost due to creep is 1 per cent. If the creep is 1½ per cent, the power lost due to creep is 1½ per cent. If the creep is 2 per cent, the power lost due to creep is 2 per cent, etc. Thus it will be seen that the power lost is proportional to and identical with the percentage of creep. It is common practice to allow 1½ to 2 per cent for creep.

It is possible to compute the percentage of creep with considerable accuracy, but this involves the use of the so-called modulus of elasticity of the material and the stress or acting force in pounds per square inch. Since the values cannot be determined without special and rather delicate instruments, the values 1½ to 2 per cent are generally taken for granted.



ILLUSTRATING BELT CREEP

Slackness or tightness of belt has practically no influence on the creep. The elasticity of a belt is approximately the same at high tension as it is at low tension in which case the creep is the same regardless of whether the belt is pulled up tight or whether it is permitted to run slack. In general, the slack belt is preferable, because of the less tension on the belt, the reduced pressure on the bearings, and the greater arc of contact of the belt on the pulleys. If the material is less elastic at low tension than at high tension—as is most often the case—the slack drive is all the more preferable.

The same rule applies to slip as applies to creep. That is, 1 per cent of slip means 1 per cent of lost power. Hence, if the creep is 2 per cent and the slip is 3 per cent, we have a total of 2 + 3 or 5 per cent lost due to combined creep and slip. On account of creep a transmission efficiency higher than 98 per cent or 98½ per cent is virtually impossible with a leather or similarly elastic belt. An efficiency of 98 per cent has actually been attained in practice.

In purchasing belts and laying out belt drives it is good engineering practice to make allowance for creep for it is inevitable and cannot be prevented.

Heat Units

Chief (trying to explain combustion to a Chinese fireman): "Do you know what B.t.u. means?"
Chink: "Sure!"
Chief: "Well, what is it?"
Chink: "You play pokee?"
Chief: "Yes?"
Chink: "Comelon! Me beatee you."

A Fire-Room Hero

DANGERS OF THIRTY YEARS AGO GREATLY REDUCED BY THE USE OF IMPROVED FITTINGS. BY J. W. SHAW

THE TELEPHONE at the chief's elbow rang insistently.

That worthy reached for the offender with a hand that showed gnarled and scarred against the polished mahogany of his desk.

"Chief?" came excitedly through the receiver.

"Yes?"

"No. 5 just blew a tube! Non-return valve O. K.! Nobody hurt! Can put No. 12 on the line in 5 min.!"

The chief singled out the recording pressure gage from the orderly array on the wall in front of him.

"Ump! Never would have known it up here, Fred. Put No. 12 on, but don't rush her. Load's light. I'll be down in a few minutes."

The chief eased the receiver onto its hook, leaned back in his swiveled chair, linked his fingers across his rather prominent middle and gave himself up to thought.

Heavens! What a difference between these and the old days!

This was just what the chief was thinking when he walked into the boiler room 20 min. later.

Thirty years he'd been at the game. Thirty yawning, hard, painstaking years; and, at last, the Goddess of Progress had so worked her magic that no longer was human life necessarily in peril upon the rupturing of a boiler tube.

Thoughts swift and sad coursed through the chief's brain as he seated himself in the boiler-room foreman's straight-backed chair.

"Fred," he called to the foreman on duty, "come over here and listen to what I am going to tell you."

Fred Haven, a youngster not much over voting age, crossed to the chief's side and stood at respectful attention.

"Got the fire out of her?"

"Wasn't much left in her, chief, but she's clean now."

The chief wrinkled his brow.

"You don't remember Jimmy McGregor do you? I know you don't when I think of it, for he died about the time you were in short pants; just 12 yr. ago this month."

"I've heard old Sandy mention his name, but that's about all. Sandy does most of his talking to himself, anyway."

"Yes, I know. That very peculiarity has something to do with what I am about to tell you.

"One dreary, rainy night in March, when I was night foreman putting in a 12-hr. shift, we had just finished our first round of cleaning. I was sitting near the door getting a little air when out of the rain and darkness, Jimmy McGregor stumbled into the boiler room. I didn't know he was Jimmy McGregor, nor do I believe he knew what his own name was that night. Dripping wet, clothes in tatters and with blood streaming from an ugly cut over his right eye, he made a picture that was anything but pleasing.

"Without a word, he walked over to one of the fires and turned his back upon it as if to dry himself. A soggy cap was canted over the undamaged eye and three weeks' growth of scraggly beard adorned his thin face. He was undersized and unhealthily thin, whether from natural causes or fasting, I could not tell.

"As I watched him, half grinning to myself at the sight he presented, he suddenly dropped to the floor in a limp heap. I jumped to his side and bent over him. As I picked him up in my arms—I don't think he weighed a hundred pounds—I caught the odor of cheap whiskey from his labored breathing. I have never had any use for whiskey in any of its forms, nor for anyone who used it and as it was against rules to allow a stranger to enter the boiler room at night without a pass, I was in doubt as to whether I would wait until he regained consciousness or throw him out at once. In my opinion, just then, he was either a tramp or just a cheap bum.

"I dropped him onto a bench near by and threw half the water from the drinking pail over his head. He came to with a start and looked up at me standing there above him. To my dying day, I'll never forget the look in that man's eyes; pain, fear, hatred, pleading—all shown in their brown depths. That settled me. This man was sick in both soul and body. I determined to help him with his body and leave his soul to his own salvation. The latter item was no affair of mine, but the former most assuredly was.

"I made him a bed of old sacking back of the boilers where it was warm, washed the blood from his face, bound up his wound with a clean handkerchief, put him to bed and tried to forget him.

"When morning came, he was still asleep. That night, when I reported for duty, my shift-mate told me that he hadn't moved all day. The first thing I did was to punch the derelict in the ribs. I found that he wasn't dead, for he asked me for something to eat. I handed him my dinner pail and he cleaned it up. I had to send home for more. Then he asked me for a job.

"I put him to work wheeling ashes and for the first few nights I thought he would play out; but he had nerve. After a week, between the nerve and what food I was bringing to him from home, he gained weight. He looked better too. His wound had healed nicely and he had but little to say. We could not get him to talk of himself or what he had been. He still slept in his bed of sacking behind the boilers, bothering nobody, doing his work better and better every night, and seeing that he wouldn't talk, the boys let him alone.

"It wasn't 'til pay day that I asked him his name and when he drew his first envelope, he placed it in my hand, saying that he hoped it would square things.

"That's how Jimmy McGregor came to us. Now, I'll tell you the rest of the story."

* * * * *

"One night Jimmy was wheeling Sandy's ashes out—Sandy was kind of an extra man and I had him firing that night. We never knew it until later, but Jimmy said something that night that angered Sandy, and you know how quick tempered Sandy is and how he talks to

himself at times—well, without a word, Sandy knocked the little fellow into the coal pile. Jimmy was unconscious for fully 5 min. and when he finally came to, the first thing he did was to apologize to Sandy. They shook hands and the incident was closed.

"On account of that column there," the chief went on, "old Nos. 5 and 6, two vertical water-tube boilers, formed a small battery all by themselves.

"It fell to my lot, one day, to see to the removing of a broken rivet in the steam drum of No. 6 and I sent Sandy into the drum to do the job. Everything was running smoothly and I could hear Sandy pecking away at that rivet; I almost imagined that I could hear him cussing the stubborn thing.

"Suddenly, a tube let go in No. 5. A deafening roar almost cracked our ear drums. Soot, ashes, and steam filled the boiler room in less than a minute. Someone yelled, 'Get Sandy,' in my ear and I felt a form brush past me. Thinking it was someone trying to get out of the boiler room, I cursed him for a coward. I pulled my jumper collar around my ears, groped for the ladder, climbed it and reached the runway. I tried three times to make it to No. 5 stop valve or to Sandy in No. 6, but the soot and steam drove me back, scalded my face and hands and blinded me until I groaned in agony and had to give it up. How I reached the boiler room floor again, I don't know. In 5 or 10 min. more the pressure gages registered zero and I went up again to shut in No. 5 and see what had become of Sandy.

"When I reached the runway this time, I could see, and there I found Jimmy McGregor stretched out, one hand clinging to the manhole rim of No. 6, the other doubled around a dirty rag which was pressed against his blistered face. I looked into No. 6 drum. It was empty! I yelled Sandy's name. His Scotch came to me from below and up he came on the run.

"Between us, we carried Jimmy below. The doctor we called pronounced him dead. It must have been Jimmy who brushed by me that time. He must have shouted in my ear, 'I'll get Sandy!' and I thought he was telling me to get him, me cursing him for a coward too. That little bundle of nerve had reached No. 6 drum where I had failed utterly. He had lost his life for a man who had struck him and knocked him unconscious.

"Let me tell you, boy, heroes do not all die on battlefields.

"The firm buried Jimmy, but we were unable to locate any relatives.

* * * * *

"That is what we had to contend with in the old days, Fred. It is the old men who really appreciate the value of non-return valves. Those men who have risked their lives to save the plant a shutdown are surely worth recognition. But do they get it? No! No more than did Jimmy McGregor. If the man lives, it is all in a day's work; if he dies, he is buried, his relatives receive some insurance and it's just another good man gone.

"You don't wonder, do you, that I thought of Jimmy McGregor when this tube blew out?"

"No, chief, I don't," Fred returned, "and I'm mighty glad that the older generation of us have lived to see that risk done away with in some plants. For the good of humanity, it should be done in all of them."

Fred paused a moment in thought. "You never told me," he continued, "how Sandy got out of No. 6 drum."

"That's so. Sandy told us afterward that when he heard the tube let go, he didn't lose any time in crawling out of the drum. By the time he reached the runway, things were too hot for him to attempt reaching the ladder, so he jumped 20 ft. to the ground outside through that window up there, sash and all. Never even scratched himself. I wouldn't ever say anything to him about it though, for he is rather touchy on the subject."

Fuel Conservation Increases

FUEL saving has been steadily increasing in the United States as a result of coal shortages, according to a paper read at the recent meeting of the American Chemical Society by Dr. Horace C. Porter.

During the last 10 yr. in America, steel production has increased by 60 per cent, railroad traffic has doubled, the automobile industry has multiplied itself 10 times—while our population has increased by only 15.2 per cent. In spite of the vastly increased industrialization thus shown, and of a much higher present standard of living, coal consumption per capita has remained practically stationary, and the consumption of all fuels has increased by a mere 7½ per cent.

In other words, fuel economy has been greatly improved, there has been a considerable increase in returns from a ton of coal. The present coal shortage would be greater if this were not so, or else our industrial development would necessarily have been restricted.

A great deal of fuel, however, is still wasted. To make fuel shortage still less a menace, both now and in the future, additional fuel conservation can be practiced. Some of it is realizable with little delay, while other forms, accomplishing more, will take time and large capital outlay.

In the first class come increased boiler furnace economy, with careful regulation of flue-gas temperatures and excess air and greater use of economizers, superheaters and feed water heaters; the application of powdered coal and gas to industrial heating furnaces as in steel and metal-working plants, and the increased use of waste heat boilers. In the second class are many major improvements whereby immense fuel saving is ultimately possible, for example, the electrification of steam railroads which, if completely accomplished in this country, would save 120,000,000 tons of coal per year. There is also the centrallization of power development in superstations, using either water power or large steam turbogenerators, by which system, to the extent of its application, at least one-third less coal would be required per unit of power sent out than in the average of the smaller stations replaced.

Large saving in fuel, notably in oil, will ultimately come from the adoption of the heating standard for gas, and a low enough standard to permit of the highest thermal efficiency in manufacture and use. By-product coking to replace the non-recovery coking still practiced in this country would save over 8,000,000 tons of coal per year, besides valuable by-products.

It is to be hoped that gradual extension of these fuel saving enterprises will continue to reduce our fuel consumption as related to industrial output, and that their influence in lessening the danger of fuel shortage and in lowering prices may more and more be felt.

Cost of Heating

I HAVE three separate buildings that are heated from one heating plant. For some time, I have been trying to find some accurate way by which the tenants could be charged for the actual amount of steam used in heating their building. I have been through articles on cost and heating and several books, and I have decided that the most accurate way is to put a condensation meter on each building (this will cost me about $400 for meter and installation). These meters weigh the water and record it so that your reading shows the amount of steam in pounds that has been used. With coal $15 per ton I would charge $1.60 per 1000 lb. of steam condensed; in my case part of the steam is exhaust. If the plant was too small, the foregoing might not cover expenses, but you must figure the total cost of maintenance, and if necessary increase the rate per 1000 lb. until everything is taken care of.

If you have no meter or cannot get one, there are three other ways that will come very close in Massachusetts:

1. Cubic contents of building × 4/5c. My size plant of 998,085 cu. ft. × 4/5 = $7984.68. My cost of running is $8000.

2. Some charge $1 for each square foot of radiating surface.

3. Some allow 1/3 to ½ lb. of water per square foot of radiating surface. Multiplying the total by $1.60 gives the charge. I figure on 212 days, average 14 hr. per day.

W. N. L.

Changes in Heater Piping

IN THIS plant, of which I took charge a short time ago, is a heater with two feeds on it, one of which feeds

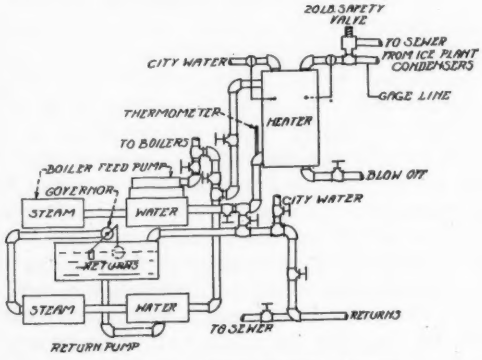


FIG. 1. FEED WATER PIPING

city water direct and the other delivers water from the ice plant condenser.

The city feed had been disconnected on account of the float valve leaking. I ground this valve and connected it to the main. Then I had to renew the piping between the condenser line float valve and heater. It was so thin that I broke a 1-in. close nipple when I picked up the pipe with one hand in trying to unscrew it. Then the heater was opened and scaled and new coke added. One float was entirely disconnected. Both feed pumps had to be repacked all over. The return pump in the boiler room is so connected as to be used for

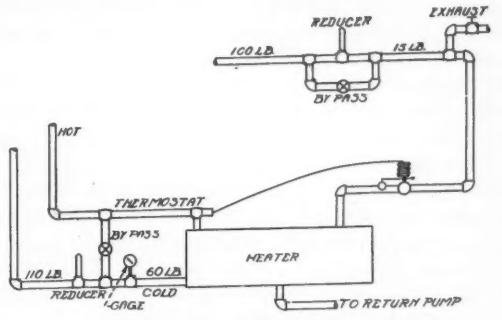


FIG. 2. SERVICE HEATER PIPING

a feeder from heater to boilers in case the other one goes bad. The governor had to be renewed. A gage line ran from the city water heater line to board. This I changed to condenser heater line and set the overflow valve for 20 lb. The overflow or safety valve spring was rotted in three pieces and the body plugged solid with hard red scale. One gage line from low pressure reducer for the hot water heater for service was plugged; when I opened it, I found I was carrying 30 lb. and I cut it down to 15. I put in a high pressure reducer in place of a low pressure to handle boiler pressure of 100 to 15 lb. The low pressure reducer here never did work and the owners wonder why.

There is a line to the service heater from the exhaust of the engine. This I closed and used live steam for heating the water, as I got it hotter and it had to serve 115 rooms and a laundry and large kitchen. I raised the pressure on the water from 40 to 60 lb. All tube ends in the heater had to be remade. The condensate from heater was drained to a high pressure bucket trap and was operated with bypass opened. I ran it to the return pump and thus ended that trouble, and I have a perfectly good trap for other uses.

R. G. SUMMERS.

Danger from Low Voltage

IT IS WELL to give publicity to the hazard of low voltages. When I first worked in power plants, I had no respect for 110 or 220 v., as I thought these voltages

were harmless. Luckily for me, it did not take any accident to awaken me to the fact that low voltages are dangerous. As I studied electricity and heard of accidents, this became more apparent to me.

At the station of which I have charge, our generator voltage is 6600 while our highest transmission line voltage is 66,000.

The new men whom I break in to take shifts here respect these voltages with very little warning, but I take special pains to warn them of our 210-v. station auxiliary bus and our exciter bus which are located on the rear of our remotely controlled switchboard.

My idea is that the greatest danger with low voltage lies in the careless use of tools, therefore I warn them to be careful with screwdrivers, wrenches and pliers when any work is done near these bus bars.

I have made the remark that I would just as soon short-circuit one of our high voltage lines with a metal tool as to short-circuit our exciter bus which has five circuit breakers which are set at 600 amp. each.

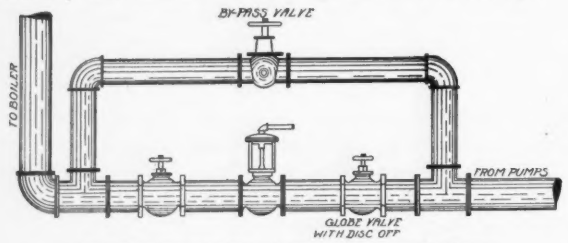
My idea is that there would be considerable melted copper flying under these conditions and that the high tension could not make it any more dangerous with breakers set to open with much less current.

To stop our hydro generators, we leave our field switches closed until the machine comes to rest. Once in awhile the switchboard operator may forget to open this switch immediately after the machine stops, therefore we caution the turbine operator to look up at the switchboard and see that the field switch is open before doing any work on the field ring brushes.

L. W. Wyss.

Globe Valve Causes Trouble

Some time in the past, it was necessary to put a new valve on the feed line, that was feeding a battery of five boilers, four of which are 400 hp. and one of 600 hp.



BY-PASS PIPING FOR AUTOMATIC FEED VALVE

These boilers are all equipped with automatic feed water regulators of the float, spring and diaphragm type, which would give trouble at times by the valve not rising from its seat to allow the water to enter the boilers, but by raising the pressure at the feed pumps the valves would rise.

The steam pressure carried on these boilers is 175 lb. gage, and the pressure at the feed pumps is 200 lb. gage; the pressure at the feed pumps is controlled by the throttle valve instead of a feed pump regulator. At this particular time, the load on the boilers was normal and the pumps were supplying the boilers without any trouble, when the 600-hp. boiler's low water alarm started to blow. The engineer, thinking that the pressure was not high enough to supply enough water, opened the throttle valve on the feed pump a little more and waited a few minutes, but the whistle continued to blow. He kept on opening the valve until he had built up such a pressure that it started all the flanged joints to leak the whole length of the feed line. He was not yet satisfied that his pressure was enough and gave the valve another turn, when the discharge line at the pump was torn apart, by stripping the nuts from the bolts at the flange. We do not know how much pressure he had, as the pen on the recording gage was out to the edge of the chart; this gage registers 350 lb. On making an inspection after this damage had been done, we found that the globe valve had been put in the line with the pressure against the packing and the disc had come loose from the stem and dropped to the seat, shutting off the supply.

This trouble could have been avoided if the engineer had not lost his head. As shown by the accompanying sketch of the valves, he could have supplied the boiler by opening up the bypass valve. It seems more good luck than good management that there were no boilers burnt or any further damage done.

C. J. Miller.

Where a Record Helped

I am reading so much lately about individual engine room log books that I thought I would like to say that I consider the log book one of the best books in the engineer's collection. I have kept one, and as a reference book, it is one of the best, giving an engineer encouragement; for when a dispute arises with the superintendent about some repair or something of a like nature, the engineer refers to his log book and the dispute is settled.

As an example, I had charge of a plant where the boilers were used for heating and got our power from a central station. We had a heating surface of 45,000 sq. ft. and I make a three weeks' test to ascertain the amount of coal, water, flue gases, temperature of feed water, and amount of ashes. The time came when the purchasing department could not get coal, so I took the matter up with the superintendent about burning oil instead of coal, as I had been corresponding with a number of places where they used crude oil for fuel and was prepared to put up an argument. To my surprise, however, the superintendent fell right in with the plan, as the company has a large casehardening department and used crude oil for its furnaces, taking the oil from a 10,000-gal. tank under the ground. I had been corresponding for some time with different firms that made oil burners for boilers, so I told him where he could get the oil burners and everything to go with them. He ordered a pair of burners for one of the boilers. I also advised him to order the other appliances big enough for the whole boiler plant, as I was satisfied that coal was becoming harder to obtain, so he ordered a large pump, and an oil meter. When they came, I installed them, put them to work making a test and submitted a copy of the test to the superintendent. He immediately ordered burners for the other boilers and also two more tanks of 10,000 gal. capacity for storing oil, and we kept a small supply of coal on hand for emergency.

We ran along for quite awhile and made a report to the superintendent every week of oil consumed, water evaporated, flue gases, average steam pressure; but one

week, it was extra cold zero weather with a high wind blowing all week and we burned some oil and when the report went in to the superintendent, he looked it over and saw the amount of oil that was consumed. He didn't look at the amount of water evaporated, but figured up the cost of the oil and telephoned for me to come to the office. He told me plainly that it cost too much to run the boiler. I told him we could not evaporate anywhere near the water if we were burning coal, since at the same rate as the test we made of coal, we did not have grate bars; in other words, our fire boxes were not large enough to consume coal enough to evaporate that amount of water. He knew better; so I went and got my log book with the amount of coal consumed per pound of water evaporated on a former test and showed him the figures, as at that time we had 45,000 sq. ft. of radiating surface and at the rating of the boiler they could take care of 29,000 sq. ft. I made them do the extra work with oil and I never could do it with coal under the circumstances under which the boilers were working.

Finally the superintendent said, "You win, but don't use any more oil than you can help, as it costs money."

The question was recently asked by the manager of a small plant which was run a certain part of the year by water power and the other part of the time by steam: "Does a boiler have to be inspected every spring?"

I say, no, not every spring but every year, as I believe every state has a law that a steam boiler over a certain pressure must be inspected once a year either by a state inspector or by an insurance inspector.

H. ARMSTRONG.

Exhaust Available and Size of Heater

IN ANY plant where pretense is to be made at economy the exhaust steam should be utilized to the fullest extent. As to how far the exhaust can be made use of depends upon a number of conditions, among the important ones being the length of the heating season, kind of engine in use, the steam pressure carried, the relation between volume of steam used for power and heating and of the heating system if already installed or is to be put in new. The first use to be made of the exhaust should be to heat the feed water, as this means a material saving the year around and can be accomplished without increasing the head pressure on engine and pump.

It is safe figuring to expect that around 80 per cent of the steam admitted to the engine is exhausted at a lower pressure and after deducting around 20 per cent of that exhausted for feed water heating the remainder can be further used. The remaining 20 per cent of the original intake to the engine being used to develop power and lost through condensation.

If we assume the average cold feed water temperature for the year entering the heater to be 60 deg. and the latent heat of steam at atmospheric pressure to be 970 B.t.u. there is 970 times 80 per cent or 776 B.t.u., 210 deg., the average temperature to which feed water can be raised, and 60 deg. that entering, it requires an absorption of 210 minus 60 or 150 B.t.u. to raise 1 lb. of water to discharge temperature from the heater. This is equal to $150 \div 776$, or $0.194 \times 100 = 19$ per cent of the heat in 1 lb. of exhaust, and means we have for other uses $100 - 19 = 0.81$; $0.81 \times 0.8 = 0.648$, or practically 64 per cent of engine exhaust. For rough figuring, we can say that if our engine requires 24 lb. of steam per horsepower hour and is 350 hp. we will draw $350 \times 24 = 8400$ lb. steam from the boilers. Now 64 per cent of 8400 lb. is 5376 lb. of exhaust for heating and process work.

The above applies to plants where no returns are recirculated to the boiler. When the volume of steam used for other purposes exceeds or equals that demanded for power and the returns are properly brought back to the boiler little if any exhaust will be needed to heat the feed water, as the only new water coming into the system in the make-up water to replace that lost through oily drips, leakage and cylinder condensation.

As the demand for exhaust decreases then the demands on the heater are greater and more exhaust up to about 20 per cent of the total is required. When the plant conditions are such that all the exhaust can be used, then ordinarily the only make-up water required is 10 per cent to be supplied to reduce the corrosive effect of the recirculation of what is practically distilled water, leakage and condensation.

Let us assume a plant where the engine requires 8400 lb. of steam per hour. The pump will take 8 per cent of that as a fair average, or 8400×0.08, or 672 lb., or $8400 + 672 = 9072$ lb. Conditions are such that of the available 9072 lb. of exhaust 7257 lb. are used and the returns come back to the boilers. The make-up water then to be heated is $9072 - 7257 = 1815$, adding 10 per cent of 9072 gives 2722 lb. to be heated hourly. Good practice dictates that heater used in connection with non-condensing engines should be proportioned on the basis of 1 sq. ft. of heating surface for each 90 lb. of water to be heated per hour and with condensing engines the heating surface should be increased 50 per cent, due to the lower steam temperature.

In our case, we shall have $2722 \div 90$ or 30 sq. ft. As heaters are sold on a horsepower basis and we allow 0.33 sq. ft. of heating surface per horsepower in non-condensing service and the horsepower rating is $30 \div 0.33 = 91$ hp. or practically 100 hp. heater.

When conditions change they must be taken into account and the heater proportioned to heat the largest quantity of water it will have pass through it. As a general rule, water should not enter a boiler under 120 deg. F. and of course the hotter the better.

RECEIVER.

A Pathetic Incident

ACCIDENTS will happen in the best regulated shop, even though Safety First is the slogan and procedure. However, in such shops accidents are at a minimum.

As many of the "boys" smoke, it may not be amiss to chronicle what follows:

Already in the hospital recovering from a previous mishap, oil soaked compresses and bandages encircling the poor man's head, yet he felt well enough to try to enjoy a smoke. When the match was placed against the pipe bowl, the bandages burst into flames and ere the fire could be extinguished, or bandages removed the poor fellow was seriously, if not fatally burned.

Be sure of what lotion any bandages you sometimes wear contain, ere you bring them near a fire.

J. B. DILLON.

Portable Oil Can Stand

A USEFUL portable oil can stand can be made with a few odds and ends. When it is nicely painted, it will

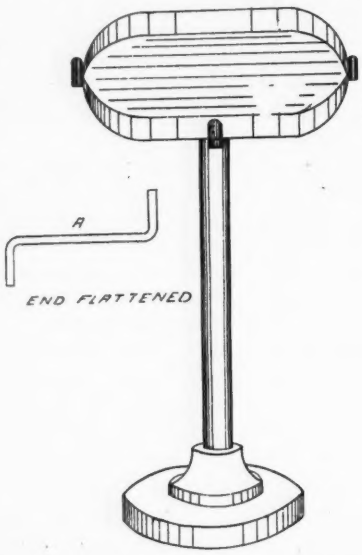


FIG. 1. METHOD OF USING MATERIALS IN MAKING STAND

compare favorably in appearance and use with the expensive factory made article. Materials required to make it are as follows: One tin can cover about 8 in. in diameter and 1 in. deep, two 1¼-in. locknuts, 30 in.

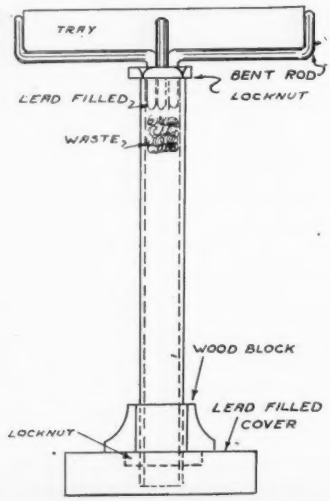


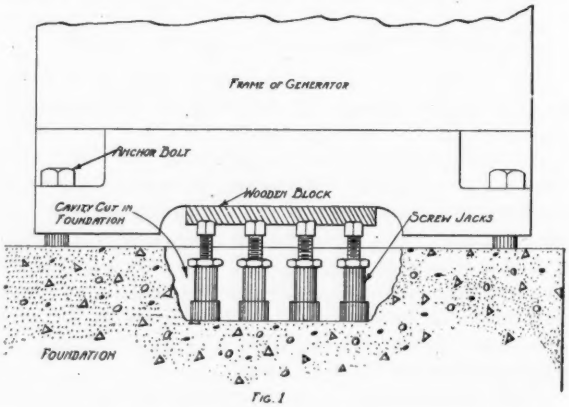
FIG. 2. DETAILS OF HOME-MADE OIL CAN STAND

of 1¼-in. iron pipe, four pieces of ⅜-in. iron rod, one 50-cent tin, glass tray about 8 or 10 lb. old lead; wood block optional.

The ⅜-in rods are bent as shown in Fig. 1 at A, one end being flattened. A plug of waste is driven into the pipe, the four pieces of rod are set in at right angles to each other and the space around them is filled in with hot melted lead. A hole is made in the center of the tin cover, the end of the pipe pushed through, the locknut screwed on, a piece of putty or clay set around the pipe, outside the cover and the cover filled with melted lead. (The locknut is placed on top end of pipe before the rods are set in.) If a turned block of wood can be secured and placed on the pipe before running the base, it makes a better looking finish. JAMES E. NOBLE.

Homemade Screw Jack

FIGURES 1 and 2 show a leveling jack recently described by A. D. Palmer. These jacks were used for alining machinery. Figure 1 illustrates their appli-



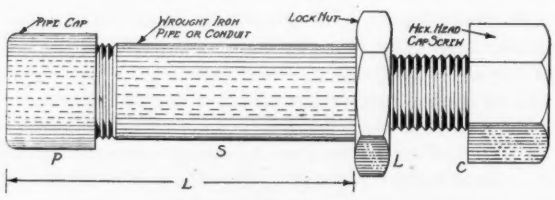


FIG. 1. APPLICATION OF HOMEMADE SCREW JACK FOR RAISING GENERATOR FRAME

FIG. 2. CONSTRUCTION OF THE HOMEMADE SCREW JACK

cation. They were used only on work where jack screws of the regularly-manufactured types were not

available. The jack comprises a length of pipe, S (Fig. 2) upon which a pipe cap, P, has been fitted, together with a cap screw, C, and a locknut, L. In using the jack, it is set under the machine and the locknut, L, is turned to raise the load. It may be necessary to hold C with another wrench while L is being turned. One-inch pipe or conduit can be used for the body, S, where the arrangement is to be utilized in raising relatively light loads. Length, L, is determined by conditions, but usually this need not be longer than 3 to 5 in. Frequently 2 in. is a sufficient length. The pipe cap, P, provides a good seat for the lower end of the jack.

HOWARD M. MELVEN.

Filter for Automobile Tire Air

THE COMPANY by which I am employed and several of the foremen have automobiles which they drive to the factory and in this case, as well as with many other mechanical problems, they come to the engineer to have him solve their troubles.

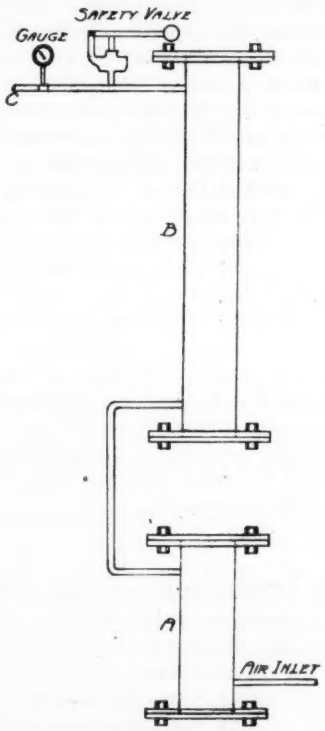


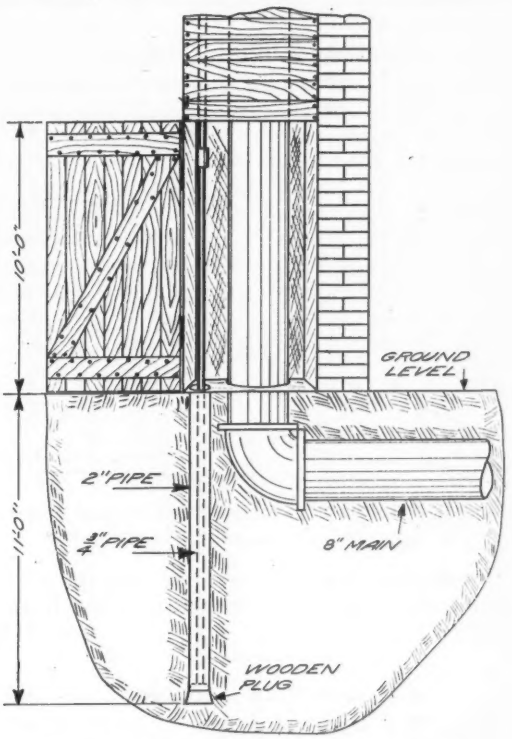
DIAGRAM OF AIR FILTER

They wanted to blow up their tires instead of pumping them by hand and as my air system has considerable oil in it, it was necessary for me to remove the oil before the air was pumped into the tires. So I constructed an air filter.

After looking over the scrap pile and ordering a few extra fittings, I made a filter similar to that shown in the sketch. Tank A is 4-in. pipe 16 in. long which is kept half full of water and waste to remove the oil. Tank B is a 4-in. pipe 3 ft. 6 in. long filled with calcium chloride which is used to remove the dampness from the air after it has passed through the water in tank A. Pipe C goes to the yard with a 20-ft. length of ¼-in. hose R. G. R.

A Pipe Fitting Kink

IN RENEWING a steam heating line to our tank for fire protection, which is about 95 ft. high, we had available 5 lengths of ¾-in. galvanized pipe about 20 ft. long. Around an 8-in. main was built a boxlike affair with three thicknesses of lumber and two of paper. At the bottom was a 10-ft. door. We wanted to put the pipes in full length, but to tear the side out of the box and



ARRANGEMENT FOR COUPLING PIPES TOGETHER

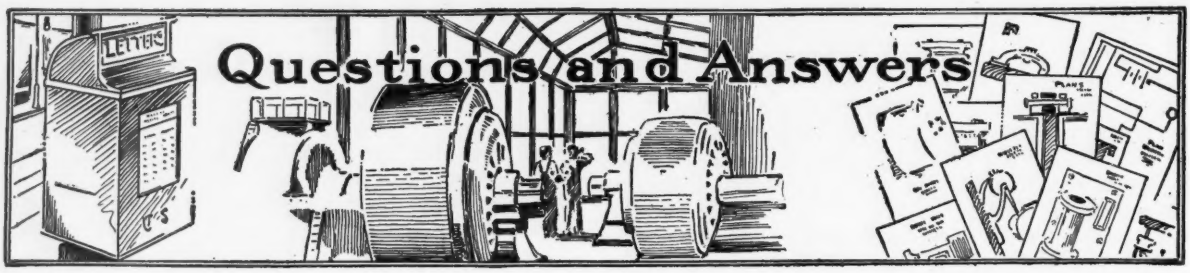
replace it properly was a big job. We took a prospecting auger and bored a 3-in. hole 11 ft. in the ground. Then we took a 2-in. pipe 12 ft. long and drove a wooden plug in one end and set in the hole. The wood plug kept the dirt out. We simply up-ended the ¾-galvanized pipe and let it down inside the 2-in. pipe, which allowed us to couple the full length pipes together in less time than it would take to tear up the 3-ply box.

J. L. YOUNG.

Polishing Hard Rubber

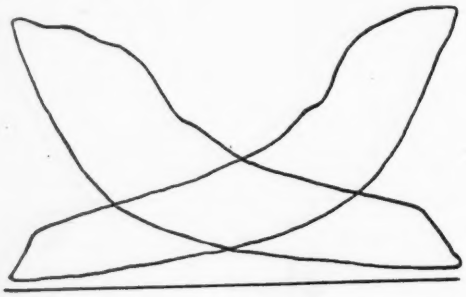
HARD RUBBER may be highly polished by the use of rotten-stone and oil. In laying off lines on a highly polished hard rubber panel, use Chinese white diluted with water. The diluted Chinese white is spread on the rubber panel with a camel's-hair brush, and, when dry, the holes and lines may be laid out. After the work is completed, the Chinese white may be easily removed with water. F. H. SWEET.

"THOSE who play the game without consideration for others may win. But it's a false joy that is garnered from that sort of victory."



Unaflow Engine Diagram

THE ACCOMPANYING card was taken from a 15 by 16-in., 247-r.p.m. Ames-Stumpf Unaflow engine with double beat poppet valves. Steam pressure, 150 lb.; load, 400 amp., 220 v.



INDICATOR CARD TAKEN FROM AMES-STUMPF UNAFLOW ENGINE

I would like to have this card criticised and improvements suggested by the readers of Power Plant Engineering. G. C. H.

Governor Trouble

WE HAVE a Hartford engine, 17 by 24 in. with a Buckeye governor and are having trouble to get the governor operating properly.

We had the valve planed, also the valve seats, and have put new pins in the rocker arms. We have tried the cutoff eccentric set at different points, but get no satisfactory results. When steam is turned on, she starts well and runs all right until she gets up to speed; but when the governor takes hold, she begins to jump and knock.

If any readers of Power Plant Engineering can give us suggestions as to what is the trouble and how to remedy it, we shall greatly appreciate the information. The engine is in good shape in other respects.

Indicator Card Criticisms

IN THE Oct. 15 issue of Power Plant Engineering were a few indicator cards for criticism and while I do not consider myself an authority, I submit my opinion of these cards as follows:

Taking first, the high and low pressure steam cylinder diagrams presented by R. J. R., it is my opinion that the card from the low pressure cylinder shows admission to be a trifle late. Release should begin at about 9/10 stroke instead of at the end of stroke, and compression on the crank end begins about 1/20 late.

As to the high pressure cylinder, admission is about right, but release is as late as in the low pressure cylinder, and I would recommend that the exhaust valve open at about 19/20 stroke if this card shows normal load, but a little earlier if load averages heavier. It would not do any harm if compression were a little higher on head end, and it should commence at about 9/10 stroke on crank end, instead of at full stroke as in the diagram.

In reference to the steam and air cylinder diagrams by Engineer, Fig. 1 shows the steam cylinder to be operating under very bad conditions. Admission is late on both ends and the expansion curve shows leakage past piston or exhaust valves, or both, and point of release is 10 per cent late on both ends. (If the atmospheric line were shown the case would be easier to diagnose.) There is practically no compression on either end and the exhaust valve should close at about 19/20 stroke for the speed indicated. It seems as though the engine exhausts into some kind of closed system where there is a partial vacuum which causes the exhaust line to fall at the point where compression should begin. The card is really a curiosity, and aside from the fact that the load is divided fairly well, conditions could not be much worse.

As to the low pressure air cylinder card, I am not able to criticize much, having had very little experience with air compressors; but will say that the intake valves do not seem to open properly at the beginning of the suction stroke, and the head end diagram shows signs of leakage past discharge valves.

L. M. REED.

A Troublesome Wedge Bolt

I HAVE in operation a 14 by 36-in. Allis-Chalmers Corliss engine, 110 lb. gage pressure, 101 r.p.m., cut off about ¼ stroke, running over. This engine has of late broken four adjusting bolts on the crank wedge block in three weeks. Crank boxes are brass shell with babbit bearings, size of pin is 4 7/16 in. in diameter and has an even bearing. It always is the top bolt that gives way. This is the bolt that draws the wedge up to take up lost motion.

I have run this engine in almost continuous service for 3 yr, two of them 23 hr. a day and never had the least bit of trouble.

What may be the cause of these bolts breaking so frequently? A. D.

A. Your difficulty is probably due to one of two causes or a combination of them. Either the back of your wedge is considerably worn, allowing it to recede from the crankpin to such an extent that a shearing effect is set up where the adjusting bolt passes through the strap, or the front of your wedge or the bearing

itself is worn to such an extent that in taking up the wear your wedge is drawn completely to the top of the space allowed for it. This would allow the adjusting bolt to be strained in tightening up. The first defect can be overcome by placing a shim or shims in back of the wedge and where the bearing or the front of the wedge is worn, these shims should be placed between the wedge and the rear bearing brass.

Erratic Motor Behavior

I HAVE a 220-v. direct-current motor which at light load runs properly, but which as soon as the load exceeds a certain value will stop and then start to rotate in opposite direction. What may be the cause of this peculiar behavior? A. L. J.

A. From what we are able to infer from your letter, it would appear to us as though the motor which you mention is of the differential compound wound type in which either the series or shunt winding predominates after a certain load is reached; that is, the motor evidently operates in the proper direction of rotation at light load, but as the load increases, line current increases in value with a corresponding increase of field strength to a point when either the series or the shunt winding becomes the stronger and, momentarily, the field flux, as a result, is zero. With, however, a slightly greater load or rate of flow of current through the field coils flux is again built up but in the opposite direction with the result that the motor is caused to reverse.

We can only give you this general information; but if you would supply us with all the name-plate data of your particular machine, we could undoubtedly give you specific instructions as to how you might be able to overcome your difficulty.

Preventing Converter Flashing

A GREAT DEAL of trouble has been experienced in the starting of a 200-kv.a. synchronous converter operating at 60 cycles, and 1200 r.p.m.

Everything works satisfactorily until after the voltage has started to rise and the field switch is closed. Then when the starting switch is thrown so as to cut out the starting resistance, there is a crash, apparent short circuits in the commutator bar and brushes; heavy arcing and sparks are thrown from the commutator, and the automatic switch is tripped.

The foregoing has occurred several times during the past 6 mo. Sometimes when the switch was thrown, it would reverse the polarity, but once the converter is cut in, it gives no trouble, not even commutator sparking. Lately, however, it has been impossible to throw it in, though it builds up to speed as long as the starting resistance is left in. The commutator, brushes, transformers and switches have been tested for shorts, opens, and grounds but without success.

Kindly give me your advice on any further tests or as to the possibility of the brushes being in an improper position, or the phases being crossed at the starting switch, or any other omission or error that you think might be the cause of the trouble. S. L. McC.

A. There are several things which might cause the converter to flash over during starting.

If the starting resistance is too large, it may cause the armature to pulsate, as will be shown by a swing of the volt-meter and the a.c. meters, and also periodic sparking at the commutator. This only occurs if the field switch is closed. If there is such a condition, the machine may flash at the commutator when the starting switch is thrown to running position. I hardly think this is so, as you have stated that the machine runs all right on the starting point.

Another thing which may cause flashing is the taking of too much time in throwing the starting switch to the running position. While the switch is being thrown, the machine is cut off from the line and the armature tends to slow down. If it is given too much time to slow down and drops partly out of step, it may flash over when the switch closes into the running position. Here, again, we hardly think this is what is taking place, because you have had a machine operating satisfactorily heretofore.

The third possibility is that the connections between the converter and the starting switch and transformer may have become changed. The following sketch shows the correct connections. If, by any chance, the connections have been changed and instead of using starting taps marked A and B, you are using tap C with either

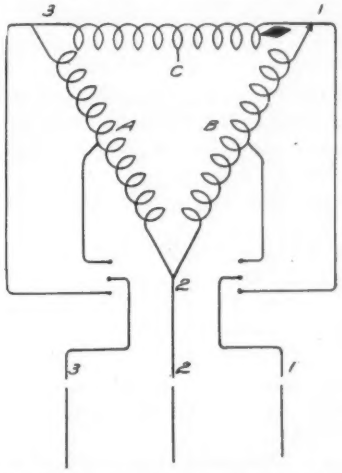


DIAGRAM SHOWING PROPER CONVERTER CONNECTIONS

of them, the machine would flash over. It is also possible that the running lines connected to the bottom terminals of the starting switch may be interchanged (1 and 3). This would cause the machine to reverse its rotation.

I would advise you, therefore, to check the connections and make sure whether or not they conform to the sketch. I shall be glad to hear from you further in connection with this matter, and if the foregoing information has not helped you to clear up the trouble we shall be pleased to go into the matter further.

T. T. HAMBLETON.

Line Pole Depreciation

OUR TRANSMISSION LINE is carried on pine and cypress poles. About what is the useful life of such poles?

How many transpositions would you make on a 2300-v. line 5 mi. in length? E. G. M.

A. A very conservative figure for the depreciation of wooden poles is approximately 10 per cent, thus providing a life of about 10 yr., although the writer knows

from his personal experience that many poles are useful even after a life of 15 yr.

We doubt very much that in your short line it will be necessary to make transposition more than once. This we would suggest making about midway between your two points of connection, that is, at a distance of about 2½ mi. from each end.

Boiler Efficiency

WILL YOU kindly explain how to determine the evaporation, efficiency, and horsepower of a boiler from the following data? M. A. G.

Boiler pressure, 90 lb. gage.....105 abs.
Feed water temperature.....212 deg.
Total water evaporated, 15 days.....7,324,000 lb.
Total coal burned, 15 days.....1,170,000 lb.

A. Actual evaporation =

$$\frac{7{,}324{,}000}{1{,}170{,}000} = 6.26 \text{ lb. water per lb. coal}$$

$$\text{Factor of evaporation} = \frac{xr + q - q_2}{970.4} =$$

$$\frac{97{,}885.2 + 302 - 180}{970.4} = \frac{980 \text{ B.t.u.}}{970.4 \text{ B.t.u.}} = 1.010$$

In this formula x is the quality of the steam delivered, r is the latent heat at the boiler pressure given, q is the heat of the water above 32 deg., and q_2 is the heat of the feed water above 32 deg.

Evaporation from and at 212 deg. $— 6.26 \times 1.01 =$ 6.32.

Assuming that you are burning Illinois coal with a B.t.u. value of 12,000, the efficiency of your boiler would be

$$E = \frac{980 \times 6.26}{12{,}000} = 51.1 \text{ per cent}$$

The total capacity of your boilers is equal to lb. water from and at 212 deg. evaporated per hour divided by 34.5

$$C = \frac{7{,}324{,}000 \times 1.01}{15 \times 24 \times 34.5} = 596 \text{ hp.}$$

Boiler Scale Trouble

WE HAVE a number of boilers with scale in them. What can be done to remove this scale? They will be idle until the cold weather G. B.

A. The common method of removing scale from steam boilers is to remove the manhole cover and put about ¼ lb. of caustic soda into the boiler for each horsepower of rating.

The boiler is then to be fired for several hours with the manhole cover still off. At the end of this time, the scale is usually soft enough to be removed readily by mechanical means.

Turbines in Parallel

WE HAVE two turbines operating in parallel. One is a 500-kw. unit and the other 1000-kw. Will the combined machines furnish 1500-kw. at full load and what per cent of the load will each carry? E. D. R.

A. Regardless of the load being carried, as long as your two turbines are running in parallel, the 500-kw. unit should be made to carry one-third of the total load while the 1000-kw. unit should be made to carry two-thirds of the total load.

It is, therefore, evident that when both machines are operating at full rated capacity, the smaller one should be carrying 500 kw. and the larger one 1000 kw.

Volume of Exhaust Steam

WHAT IS the correct way of figuring the volume of steam exhausted from an engine; for instance, a simple engine 13 by 17 in., 225 r.p.m., 125 lb. gage? W. B. M.

A. The volume of steam issuing from an engine in a given time depends upon the size of the engine, the speed and the load it is carrying. The cubic feet per minute at existing back pressure in the exhaust piping is equal to the volume of the cylinder times the per cent cutoff times the density at cutoff pressure, divided by the density at the existing back pressure times two times the revolutions per minute.

Case 1. Assuming ¼ cutoff.
Cutoff pressure 140 lb.
Back pressure 14.7 lb.

Cu. ft. per min. =

$$0.7854 \times \frac{13^2 \times 17}{1728} \times \tfrac{1}{4} \times \frac{0.3107}{0.0373} \times 2 \times 225 = 1225$$

It will be seen from the foregoing equation that if the back pressure is reduced, the density at back pressure will also be reduced and the volume will be proportionately larger, provided the cutoff is kept at the same place. If, however, the same power is to be developed, the cutoff would be lessened and the exhaust volume reduced, bringing it back to about its former value.

Air in Water System

IF A ROOF TANK is full of water, what may be the cause of a stoppage of water flow on the third and fourth floors of the building? Whenever a faucet is opened, it appears as if the pipes are full of air. O. P.

A. The condition to which you refer in your water supply system can only be due to some defects in the pipe. If, however, the air in the pipes is only a temporary condition, the water following after the faucet is open a few seconds, would be due to a considerable amount of air in your water and to the faucets having remained closed for some length of time.

Lining Up Shafts; Babbiting Bearings

KINDLY advise me how best and quickest to line up a line shaft. How to babbit an engine bearing. C. S. F.

A. A line shaft can easily be leveled by means of an ordinary carpenter's level and a straightedge long enough to reach from one bearing to another. A good method of lining the shaft horizontally is to stretch a wire a short distance above the shaft and use this as a guide in adjusting the hanger set screws.

In babbiting an engine bearing, the first thing to do is to make sure that the cavity into which the metal is

to be poured is perfectly dry. The shaft or a mandrel turned to a suitable size is then put into place and a piece of wrapping paper wrapped around it and the ends of the opening closed up with putty or clay. For the better class of work, it is usual to employ a mandrel instead of the shaft which is to run into the bearing. After the mandrel has been removed, the babbit is frequently peened and is sometimes machined and scraped.

Heating Feed Water

I WANT A CHEAP heater for boiler water. Would it be practical to tap my feed line and go through the boiler wall just behind the bridge wall and put a series of return pipes in the combustion chamber?

W. E. P.

A. We would advise against installing a feed-water heater such as you suggest. You would gain nothing thermodynamically because you are heating no more water than you did in the original installation. This idea might relieve the boiler of some strain due to cold feed water; but, on the other hand, you would constantly be having trouble with scale in the coils and pumps.

If you have any exhaust steam available we would suggest the installation of the usual open or closed feed water heater.

Removing Oil from Belts

WE HAVE a 2-ply 24-in. leather belt which gives us a lot of trouble by slippage. This belt is soaked with oil through and through. How may I remove this oil without injury to the belt? E. S.

A. Probably the best way to clean a leather belt is to remove the belt from service for some time and either soak it in gasoline, afterwards scraping it dry and treating it with belt dressing or as an alternative to scrub the belt thoroughly with a solution consisting of two parts of gasoline and naphtha and one part of turpentine.

Another method that has been used, apparently with some success, is to dust powdered chalk on the belt and roll it up, allowing it to remain thus for several days. At the end of this time it should be scraped thoroughly, dried and treated with belt dressing if necessary.

Hollow or Solid Conductors?

WILL a conductor such as a copper tube carry the same amount of direct current with the same resistance as a solid copper wire of like outside diameter?

Also, what is meant by the "cross sectional area" when finding the resistance of a conductor?

W. K.

A. A conductor such as a copper tube will not carry the same current as a solid copper wire of the same diameter, as the cross-sectional area of the tube would be smaller and it would consequently heat up much quicker than the solid wire.

The cross-sectional area of a wire or tube is the area of that surface of the metal exposed when the wire or tube is cut at right angles to its axis. It will be seen from this that the cross-sectional area of a tube is smaller than that of a wire of the same size by the area of the hollow center of the tube.

Removing Burnt-Out Coils

WHAT is the method of cutting out coils that are burned out, both a.c. and d.c.? T. U. W.

A. A method of cutting a burnt-out coil in a d.c. armature is to disconnect the two leads of the coil and solder a jumper between the two sections of the commutator between which the coil was connected. In an a.c. motor, the same method is employed except that the jumper is to be soldered between the two coils between which the burnt-out coil was connected.

Starting Current for D. C. Motors

WILL YOU kindly tell me what the starting current of a d.c. motor is as compared with the running current? In other words, how much more current does it take to start the motor than to operate it after it is up to speed?

R. A. D.

A. The amount of starting current required by any direct-current motor varies with the size of the machine and may range from 175 to 200 per cent of the running current, the running current assumed to be 100 per cent.

Magnets in a Watt Meter

OF WHAT USE are the magnets in a watt meter?

J. M.

A. The permanent magnets used in a watt meter are for the purpose of damping or retarding the movement of the revolving member. Without such magnets it would be impossible to adjust the speed of the revolving member to such a value as would provide the correct number of rotations for a given amount of energy.

Squaring the Circle

COULD YOU OBLIGE me by describing in as simple terms as possible the rule for squaring the circle? J. W.

A. The ratio of the area of a circle to its diameter is incommensurable, consequently the dimensions of a square whose area is equal exactly to that of any given circle cannot be given in figures.

An approximate method of finding a square whose area equals that of the circle without using the incommensurable ratio 3.14159, is to inscribe in a given circle a square and to three times the diameter add one-fifth of the side of this square. Multiply the radius squared by this number and then extract the square root. The answer is the length of the side of a square of area approximately equal that of the circle.

Ice Storage Capacity

HOW LARGE a storage would you advise in connection with a 35-ton refrigerating plant? E. L.

A. We would suggest allowing about 1000 cu. ft. of space for each ton of refrigeration capacity. If, therefore, as you state you have a 35-ton plant, this could well care for 35,000 cu. ft.

COAL OPERATORS in Alabama have been informed by State Fuel Administrator that their entire production of domestic coal between Oct. 30 and Nov. 6, must be sold and delivered only in the State of Alabama.—Industrial News Survey.

POWER PLANT ENGINEERING

Trade-Mark, Reg. U. S. Pat. Office

Issued the 1st and 15th of each month. Established over 24 yr.

Published by the TECHNICAL PUBLISHING CO.
537 South Dearborn Street, Chicago.
New York Office, 150 Nassau St.

Subscription price $2.00 a year in postal zones 1, 2, 3, 4 and 5, which include all postoffices within a distance of 1400 miles from Chicago.

Subscription price $2.50 a year in postal zones 6, 7 and 8, which include all postoffices more than 1400 miles from Chicago.

Copies, current issue, 15 cents; back numbers, 25 cents.

Notify us at once of any change of address, giving the old and the new address, so that your paper may always reach you promptly.

Copyright, 1920, by Technical Publishing Co.

Entered as second class matter May 1, 1908, at the Post Office at Chicago, Illinois, under the act of March 3, 1879.

Member, Associated Business Papers.
Member, Audit Bureau of Circulations.

Circulation of this issue 22,100

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Are Engineers Irresolute?

About 18 months ago, the movement was started by a group of representatives of engineering societies to introduce a bill reorganizing the Development of the Interior into a Department of Public Works which should look after the engineering activities of the government and co-ordinate them so as to secure efficient planning and construction, and supervision by competent engineers.

This aroused much enthusiasm among all engineers, and was hailed as a first big step toward giving engineering proper recognition of its importance to the public welfare. The National Public Works Department Association was organized and a campaign started to develop public opinion and impress members of Congress favorably to reorganization of government departments so that they would function effectively.

This campaign has been so successful that a general movement has begun in favor of an investigation of all departments with a view to redistributing the work of the government so that all like work will be collected into one place where experts can concentrate on it.

For the first six months after the movement was started, good support was given by the engineers, both in financial aid and in spreading propaganda to create favorable interest. Their interest began to lag, and for the last six months, the N. D. P. W. Association has been carried on by other than engineer financing, while the assistance given by engineers in influencing Congress and the public has been practically nothing. Those who have been working hard in the matter are asking, "Do not the engineers of the country care about public welfare? And do they not appreciate the prestige to be gained by having an entire department devoted to engineering with an engineer at its head as a member of the Cabinet?"

In a recent address to the American Institute of Mining Engineers, of which he is president, Herbert Hoover pointed out the need of a national policy on such great matters as development of transportation by rail, highways and waterways; conservation of coal and oil, reforestation and securing control of oil resources outside our borders; development of power and distribution systems, including hydroelectric developments and allied water storage systems for irrigation; all problems so big that they are beyond the possibility of private co-ordination, and need the steadying and correlating power of a well thought out national policy.

These things need immediate and continuous attention. They are fundamentally engineering matters and should be considered and controlled by engineers through a department which makes such work its sole and vital business.

The immediate question is one of supporting and influencing opinion rather than of finances. Have engineers started something which they cannot or will not finish? Every engineer can help by writing to his representative in Congress and by using his influence to get others to do the same; also by advocating the passage of resolutions by his association and forwarding them to members of Congress urging the passage of the bill to recast the Department of the Interior into a Department of Public Works.

Fuel Economy Number

SYNOPSIS OF CONTENTS OF THE SPECIALIZED ISSUE TO BE PUBLISHED JANUARY 1, 1921

FUEL prices have risen, are rising, and are likely to rise still further in future. For costs of mining, of hauling and handling are increasing steadily, and our most easily mined sources are being rapidly depleted.

For the man who uses power, and especially for the engineer who is responsible for the manufacture and utilizing of power, the question of keeping down the fuel cost, fuel waste and waste of the power derived from fuel is of vital importance, and will become more and more an insistent problem.

The Issue of Jan. 1, 1921, will be devoted to an investigation of the causes of fuel and power wastes, and to pointing out how costs of handling, storing and burning may be reduced; how wastes may be avoided and the maximum of power delivered and utilized at a minimum of expense.

FUEL HANDLING AND STORAGE

IN THE first main division will be taken up the Handling, Storage and Burning of Fuel. Costs will be compared of manual and mechanical handling of coal and ashes, various types of conveyors and the uses and sizes of plants to which they are suited to give best economy.

This will involve consideration of barrows and small cars, bucket and fluid conveyors, belts, screw and scraper systems, skip hoists, bins, hopper cars and portable conveyors.

Economy of storage calls for a consideration of all available locations for storage, in buildings, yards and distant lots, with cost of rehandling, and selection of the most economical method. Fire risk must be considered as well as available methods for piling and reclaiming, and local conditions always are a large factor in determining what system to use.

FIRING

AN IMPORTANT phase of the subject is the firing. In this connection characteristics of the coal must be considered when selecting the furnace; volatile, fixed carbon, ash and moisture have an important bearing on the type and dimensions of furnace to be used; and these matters as well as special furnace features, such as heat reflecting baffles, mixing arches, water backs and draft control will be given adequate treatment. Also the various types of stokers and their use with various coals. Burning of each kind of fuel is a special problem both in furnace details and in method of firing, and the fireman must know how to handle the fuel given him to the best advantage, for various rates of combustion. In this issue he will find the information that he needs to get results, to prevent ashpit losses, to keep furnace conditions right and to handle his stoker if he has one.

In connection with this subject, the apparatus needed will be considered, such as baffle walls, grates, draft control devices, special arches, draft gages, instruments for testing gases, flow meters, and pyrometers.

SPECIAL FUELS

BESIDES COAL, we have in the plant to deal with other fuels, oil, gas, wood waste, bagasse, low grade dust and slack; and the use of these, as well as colloidal fuel and pulverized fuel, will be considered. This will cover types of furnaces, baffles and burners to be used; storing and feeding fuel and the comparative cost, under different conditions, of using coal and the other fuels. Also the advantages in respect to handling, and difficulties which may be anticipated either in securing adequate supply or in operating the special equipment required.

PLANT WASTES

UNDER THIS, the second main division, the effect of dirty surfaces in the boiler will be shown, how to get best results in heat transmission, and the latest developments in increasing boiler and heater efficiency.

Keeping furnaces and boilers free of soot and ashes by blowers, and preventing or removing scale by water treatment, tube cleaners, skimming and blowing down will have an important section in this division.

Steam wastes will be comprehensively covered so that the heat which has been generated and transmitted with best economy may not be thrown away.

The use of traps, insulating covering, devices for stopping leaks, methods of keeping joints and valves tight and avoiding waste from idle steam lines will be fully covered.

This section will cover the whole system from the furnace to the prime mover, prying into every source of waste and showing how to conserve every possible heat unit which the fuel has yielded. The subject is too big to go into details in an outline of the number, but it will be covered.

LOAD REGULATION

THE THIRD main topic will be Regulation of Power Plant Loads to give maximum economy of machinery and reduce losses in the transmission and distribution systems. Among the subjects to be discussed will be: Planning to get steady load; forcing to carry peak loads vs. extra capacity; dispatching of equipment in service; block service to utilize capacity of installations.

To get results, the use of recording and indicating instruments is essential, and proper control involves ready means of communication between switch room, engine room and boiler room. It also requires a knowledge of the capacity and action of the various units such as can come only from full data from makers, or complete tests and observation under working condition. The apparatus required will be fully described.

Losses such as occur in the transmission and distribution lines of electric, air, water, steam and refrigeration systems will be pointed out and detailed explanations given as to their detection, location and elimination. The effect on the individual unit and on the entire system of idle and underloaded motors and transformers will be taken up in detail and suggestions for proper corrective measures presented.

The concluding paragraphs will give a detailed treatment of the detrimental effects of low power factor, together with directions for its improvement.

Instrument for Measuring Recoverance

A NEW FORM of testing machine, known as the Modulimeter, has recently been developed for the measurement of the recoverance of various materials. Recoverance is the name given by the Widney Test Laboratories to a property which is inherent in all matter to a great or lesser degree.

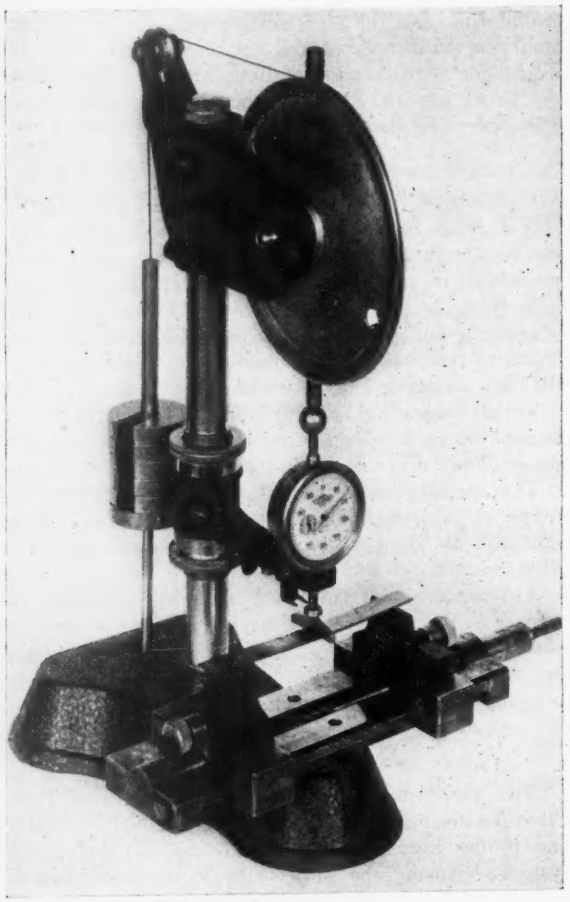


FIG. 1. THE MODULIMETER

This property recoverance is defined as the capacity of a material to return immediately the energy that has been imparted to it by any external force. In other words, when the molecules of a material are forced by compression, tension, or bending from their relative normal position, the force immediately exerted by these molecules after the disturbing force is removed in their return toward such normal position is the recoverance of the material. Extensive research has been carried on by the Widney Test Laboratories with a view to relating the recoverance values of various materials with the fatigue, wear, and durability values of these materials in such a way that the adaptability and quality of any material for any specific purpose may be arrived at in simple, understandable terms by simple, quick tests.

By means of the Modulimeter illustrated in Fig. 1, the recoverance of metals is determined in the following manner: A metal sample, ground and polished, 6 in. long by 0.25 in. wide and 0.05 in. thick is placed on the knife edges at the base of the instrument. These knife edges are 4 in. apart. A gage graduated to thousandths of an inch is directly connected to the plunger which is in turn directly connected to the third knife edge. This third knife edge is equidistant from each of the supporting edges. With the sample to be tested in position, equal increments of load of either 50 or 100 grams each, depending upon the material, are placed on a platform carried by the plunger.

A predetermined load is applied in successive equal increments; i.e., if the predetermined load is to be 1000 grams it will be applied in either 20-50-gram increments or ten 100-gram increments. After each increment, the deflection is noted and likewise when each decrement is removed, the corresponding deflection is noted. The result then is a loading curve and an unloading curve. The ratio of the area beneath the unloading curve to the total area under the loading curve is the recoverance expressed in per cent.

A curve of this kind is shown in Fig. 2. The material is loaded in 20 increments, giving a certain deflection. This material is then unloaded and a slight loop is developed, although the material comes back to the point of

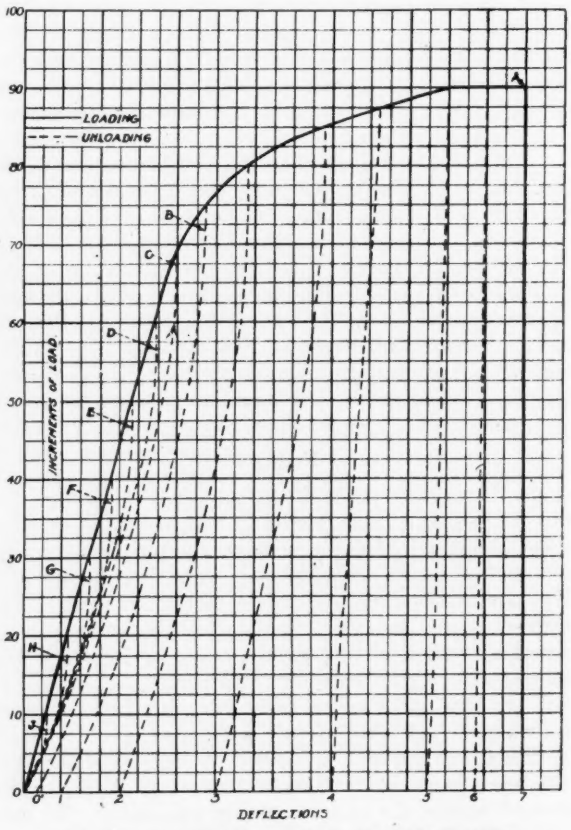


FIG. 2. GRAPHICAL THEORY OF RECOVERANCE

beginning when all the load is removed. The resultant of the subtraction of the area of this loop from the total area underneath the increment curve is the recoverance area.

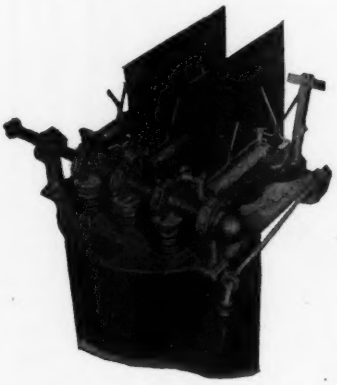
The unloading line does not come back on the same points on the loading line, although if the total stress applied is within the elastic limit, the last point will be at the point of beginning as previously stated. It is

obvious, then, that when a material is subjected to repeated stresses, there will be as many of these loops formed as there are complete cycles of stress and as the area bounded by loop represents a loss in strength to the material, and if the rate of repetition of stress is greater than the rate of recoverance, a certain per cent of this loop would be held over from one repetition to the next. As the repetitions continue, the magnitude of this loop would naturally increase much as shown in Fig. 2, as curves G, F, E, D, C, B and A, until Curve C is reached. This curve would not come back to the origin, O, consequently at this curve the elastic limit would have been reached and the material will have taken a permanent set.

The Modulimeter concerns itself only with the immediate recoverance of a material and has nothing to do with the fact that the material might recover completely after being allowed to rest sufficiently. The instrument is adapted to measure the recoverance properties of any kind of metal and should prove of great value in the selection of suitable materials for machinery in which the parts are constantly subjected to alternating stresses.

Self-Contained, Low-Voltage Indoor Mounting Electrolytic Lighting Arrester

MOUNTING the transfer switch and gap structure on the tank top is one of the main features of a 1000-7500-v. type lightning arrester recently placed upon the market. This arrester is self-contained and of the indoor mounting form. Transfer switch, horn gaps, charging resistance and short-circuiting devices are all located on the tank top. The tank and tray structure is the same as that of previous models of this



TRANSFER SWITCH AND GAP STRUCTURE AS MOUNTED ON TOP OF TANK

arrester, the only difference in construction being the elimination of the wall mounting form of transfer switch and gap structure.

The transfer switch is of the sliding rod type, consisting of a rod with sections of conducting and insulating materials, operating through five self-alining contacts, supported by the cover. Three middle contacts are insulated from the tank cover by porcelain pillar insulators, but the end contacts are connected directly to the tank top through their metal supports and form a part of the ground circuit. A ball handle with guard provides an easy method of operating the switch.

The horn gap, charging resistance and short circuiting device, are mounted on insulating bases located between barriers and on the tank top. Short-circuiting metal strips are carried by insulated supports attached to a shaft. The shaft or rod is operated by means of a rope or handle against a spring which normally holds the short-circuiting device in the open position.

Peat Blocks for Fuel

SO SERIOUS is the fuel situation in the Baltic States that the Government of Latvia is considering the issuing of wood and peat cards in much the same manner as the other governments of Europe issued, during the war, bread, sugar and milk cards.

As a result of this threatened fuel shortage, the Latvian Government has turned its attention to the harvesting of the vast peat deposits which are to be found about Riga, in the country around Kovno, and in other sections. Already the peat market in Riga is one of the interesting spots in the city, while the gathering and preparing of it is furnishing employment for scores of men and women.

Peat is merely decaying vegetable matter found about stagnant water. When harvested, it is cut into bricks and stacked to dry. The completed product as it appears in the market resembles in shape somewhat the blocks of compressed coal used on European railroads. To prevent profiteering, the Government will place a fixed price upon peat bricks.

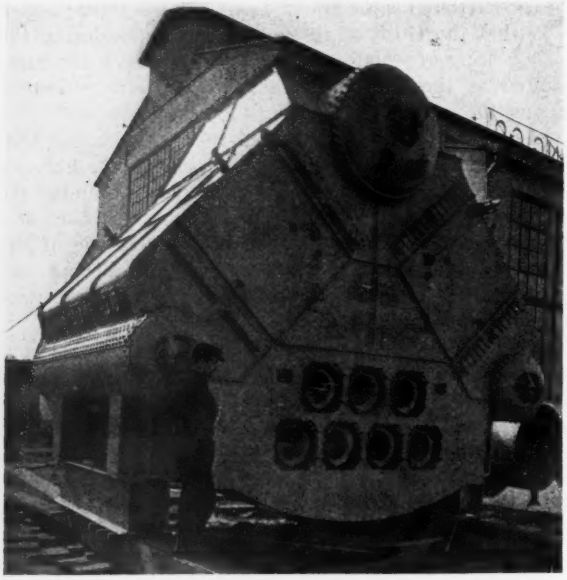
In this attempt to educate the people in the use of peat, the various stations of the American Red Cross are setting an example by using it for cooking purposes. At the same time, Red Cross officers are conducting experiments with a combination of peat and other materials in an endeavor to find a fuel which may be used in the manufacturing plants about Riga and thereby reduce the drain on the wood supply of the country.

COAL in moderate quantities is being shipped to European ports, mainly Scandinavian ports, from Australia, but it is intimated that the Australian government will place an embargo on this trade in order to protect the home demand. Freight rates for this traffic, which were 175 shillings a ton a few weeks ago, now are quoted at about 150 shillings.

Calcutta also threatens to place an embargo on coal exports. With the Australian and Indian sources closed, the European countries are expected to give more attention to obtaining coal from China. Fabulous figures are quoted on China's coal wealth. A recent estimate places it at 995 billion tons, as compared with a European total of about 200 billions. China's domestic requirements are about 20 million tons a year, so there is plenty to spare if the transport problem can be solved. Chinese coal is not of very good quality, but that fact is willingly overlooked in the mad scramble for coal of any kind whatsoever.—The Review.

Water-Tube Marine Boiler

THE BOILER here illustrated, recently built for the U. S. Naval Experimental Station at Annapolis, Md., is of special interest because of its large size and extremely high pressure. It is 15 ft. high, 17½ ft. wide and 12 ft. deep, with a furnace of approximately 500 cu. ft. volume. Its weight is 85,000 lb. complete. It was built for a working steam pressure of 350 lb. and tested to 550 lb. hydraulic pressure. The steam drum is 48 in. by 12 ft., with a tube sheet 1 13/16 in. thick. The water drums are 30 in. by 12 ft., with tube sheets 1 13/16 in. thick. All drums have double butt strap and double riveted joints.



FRONT VIEW WATER-TUBE MARINE BOILER BUILT FOR U. S. NAVAL EXPERIMENT STATION

The tubes are of cold drawn seamless steel, No. 10 gage, 1⅝ in. outside diameter. Casing is of No. 10 gage steel plate backed with asbestos mill board and 2 in. of high-tempered special insulating material. The combustion chamber has a 9-in. fire brick lining backed up with the same insulating material mentioned above. The bottom of the furnace is shaped on the arc of a circle to allow for the proper expansion of the brick lining.

The unit is equipped with cleaning openings for each bank of tubes and also with automatic soot blowers, the latter being operated by a chain pull. They automatically dispose of water of condensation in the piping and also shut off the steam automatically after cleaning is completed.

This boiler was too large to be shipped by rail and it was therefore transported on a barge, completely assembled, as here illustrated. On arrival at the Naval Station, it was necessary only to set it on its foundation and connect up piping and smokestack. No mason work or boiler setting was required.

This equipment was built in the shops of the New York Engineering Co. at Yonkers-on-the-Hudson, New York.

Water Level Indicator for Boilers

THE ordinary method of checking the water level in a steam boiler by means of test cocks has the disadvantage that with such pressures as are now in use the fluid issuing from the cocks, when they are open, is in the form of a jet which is practically the same whether the water level be above, or below, the test cock. Partly in view of this it has long been usual in good practice to fit two water-level gage glasses instead of one. Even so, however, it is possible that the two glasses may be out of action at once, and in some cases it is not always easy to distinguish between a full glass and an empty one. A simple and effective form of water-level indicator which has all the advantages of the test cocks in checking the water level, but does not suffer from their disadvantages, has been introduced in

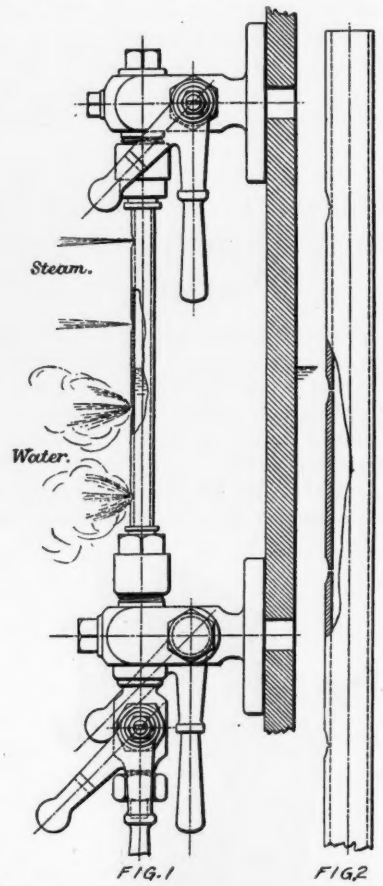


FIG. 1. SHOWING DIFFERENCE IN APPEARANCE OF THE STEAM AND WATER JETS

FIG. 2. DETAILS OF METAL GAGE TUBE

Great Britain, says Engineering (London). It consists of a metal tube of external diameter and length such that it may replace the glass tube in an ordinary water gage. The metal tube is drilled with a series of small holes about 1/32 in. diameter, and at a pitch of a few inches apart.

When this tube is in position on a boiler and the gage cocks are open so that it is put in communication with the water and steam spaces, it is found that the jets which issue from the holes which are below the

water level are very distinct in character from those which issue from the holes above the water level. The steam jets issuing above the water level are barely visible and have a very small angle of divergence, while the jets below the water level are in the nature of a distinct white, cloudy spray, and have a wide angle of divergence. This is illustrated in Fig. 1, which shows an indicator in operation. It will be clear that this device enables a very close reading of the water level to be obtained with ease and certainty, and that there is nothing in it to go wrong. A hole may be stopped up, but if this happens it is at once evident and may easily be cleared. With the size of holes used, 1/32 in. diameter, this minor trouble is not very likely to occur. It is found that the best contrast between the jets is obtained when the length of the jet passage is equal to its diameter, and to obtain this proportion a flat is filed on the tube at the point where the hole is drilled. This is indicated in the general drawing, Fig. 1, and the detail of the tube, Fig. 2. It will be evident that these distinctive jets may be obtained by fitting suitable nozzles to ordinary test cocks, but the arrangement would not give the close reading of water level which is obtained with the indicator, unless an unusual and probably undesirable number of test cocks were fitted.

Strength of Welded Pipe Joints

THE STRENGTH of pipe joints welded by means of the oxy-acetylene process is shown by a series of interesting tests conducted at the plant of the Linde Air Products Co. during the period of the Buffalo gas show. The first test piece consisted of two short pieces

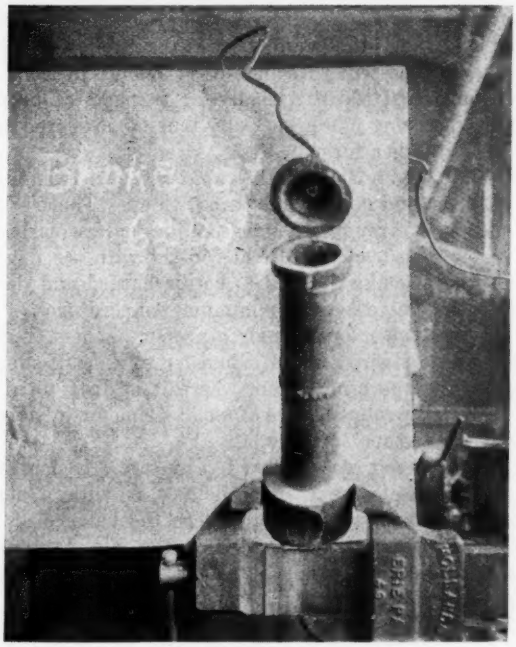


FIG. 1. EXTRA HEAVY CAST-IRON CAP BLOWN OFF AT 6200 LB. PRESSURE, WITHOUT DAMAGE TO PIPE OR WELD

of 3-in. standard pipe welded together end to end. The outer ends were capped with standard cast-iron caps. When cold water pressure was applied, the top of one of the caps blew off, without injury to pipe or weld. The same pipe was then fitted with extra heavy cast-iron caps, and, again, one was blown off, this time at a pressure of 6200 lb. per square inch. Figure 1 shows how the caps failed.

For the third test extra strong steel caps were used, with the result that the pipe split open lengthwise from one of the caps up to the welded joint where it stopped.

Two further tests were made with 4-in. pipe welded

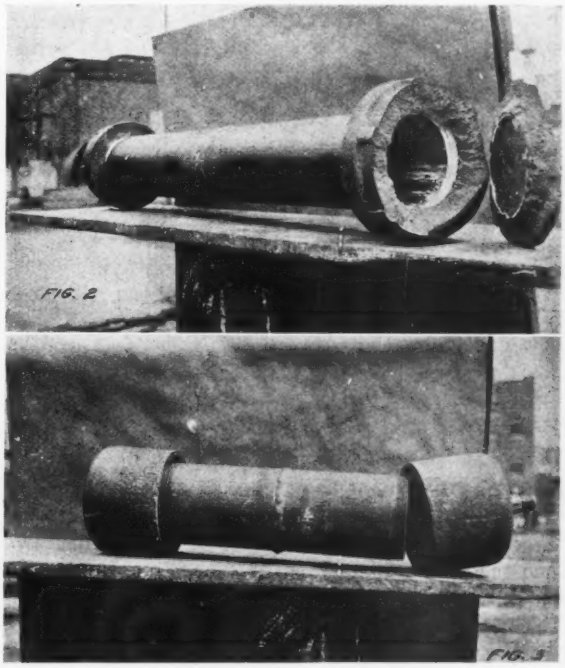


FIG. 2. THIS 4-IN. EXTRA HEAVY STANDARD CAP FAILED AT 4400-LB. PER SQ. IN.

FIG. 3. IN THIS CASE, THE 4-IN. PIPE FAILED IN THE THREADS CLOSE TO THE END OF THE EXTRA HEAVY STEEL CAP

together in the same manner as the 3-in. pipe, in the first three tests. Extra heavy cast-iron caps were first used with the result shown in Fig. 2. This cap failed at 4400 lb. per square inch, or nearly 33 tons total end pressure, without effect on the weld. Two shorter lengths of 4-in. pipe were then welded together and capped with extra heavy steel caps. This time the pipe failed in the threads close to the cap, as shown in Fig. 3, under a pressure of 4200 lb. per square inch. In all of the tests described, the welds held securely.

The use of oxy-acetylene welded joints in oil pipe lines, gas and water mains, and laterals, is increasing and is frequently specified in preference to riveted or threaded joints. The advantages of the welded joints are great strength and low cost of construction.

W. S. MURRAY, Chairman of the Super-Power Committee of the United States Geological Survey, will deliver an address before the Westinghouse Club, Wilkinsburg, Pa., on the evening of Nov. 18. Mr. Murray will tell of the proposed super-power system which will connect electrically the hydroelectric plants of New England and the South with the Tide Water plants and large central stations at the mouths of coal mines.

Arc Splitter Doubles Life of Magnetic Contactor Tips

THE LIFE of contactor tips used in connection with electrical control apparatus is said to be doubled by means of an improvement recently developed. Inasmuch as magnetic control apparatus is now used for the control of electric motors in practically every industry this development of the "arc splitter"

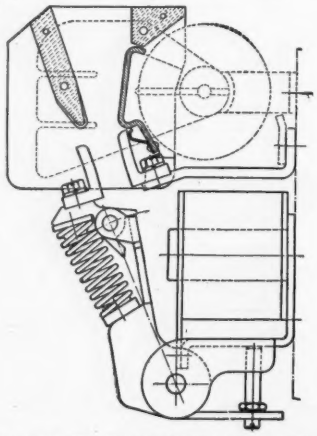


FIG. 1. SECTION THROUGH MAGNETIC BLOW-OUT CONTACTOR WITH ARC SPLITTER

is of considerable interest. Also the reliability of any control system is directly dependent upon the reliability of the contactor, and the contactor is in turn dependent upon the proper functioning and durability of the contact tips.

This arc splitter consists of a refractory element which is so placed in the arc box of the magnetic blowout as to project into the path of the arc. This projection forces the arc to pass around it and thereby lengthening its path. The lengthening of the arc increases its resistance and causes it to rupture more

FIG. 2. ACTION OF MAGNETIC BLOW-OUT WITHOUT ARC SPLITTER

FIG. 3. ACTION OF MAGNETIC BLOW-OUT WITH ARC SPLITTER

rapidly. In addition, the travel of the arc over the surface of the arc splitter tends to cool the arc gases, which also causes the arc to rupture more rapidly. Quick arc rupture reduces the wear on the contacts and thus increases the life and reliability not only of the contactor but of the entire control system.

As shown in the diagram, the arc splitter is immediately above the contactor tips. A transverse magnetic field is produced by the magnetic blowout where the arc occurs. The action of the arc in this field is similar to the action which takes place in a motor when a current carrying conductor is placed in a magnetic field. The conductor, which in this case is the arc, moves in the same direction as it would in an electric motor. The arc is forced out by this movement and consequently lengthened. The action not only lengthens the arc, but also forces the arc against the arc splitter which accentuates this action.

The effect of the arc splitter is shown in the accompanying photographs. The illustration of Fig. 2 shows the flash when the arc splitter is not used, whereas the illustration of Fig. 3 shows the flash when arc splitter is used, the photographs being taken under identical load conditions. This shows the striking difference between the two operating conditions and the advantage of the use of the arc splitter.

Burning Coal at 100 Per Cent B. t. u. Efficiency*

By W. O. Renkin

IN BURNING coal in powdered form, the excess air can be, when necessary, eliminated, as the powdered coal is fed into the furnaces in a cloud where each particle quickly secures the air needed for combustion. The amount of excess air, therefore, is always under control, thus securing the greatest B.t.u. efficiency.

The early mechanical difficulties in connection with the preparation and distribution of powdered coal have been commercially overcome, thereby making it possible to use much of the low grade coal heretofore wasted. In fact, recently coal having as high as 25 per cent ash has been used.

It is now possible to use efficiently any grade of coal in powdered form, yet you understand the cheapest coal in the long run is the one that gives the greatest number of B.t.u. for one cent with the lowest amount of ash.

To burn coal efficiently calls for furnaces of proper design; this being more especially true of powdered coal than of any other form.

In the Quigley system, the powdered coal is handled in bulk form and not as a mixture with air. The crushed coal is passed through a double-shell dryer in which only the cooler gases come in direct contact with the drying coal, which permits the coal to be discharged and delivered to the pulverizer at minimum temperatures.

The coal, when pulverized to proper fineness, is separated and delivered by an exhauster to a small supply bin over transport unit from where it is distributed in bulk through wrought pipes of small diameter to storage bins at the various furnaces.

The powdered coal is then fed by screw feeders into low pressure ejectors, which deliver it with a small amount of air to the burner, where the balance of air needed for combustion is added at the minimum pressure necessary for proper burning in the combustion chamber.

The coal does not receive the air necessary for combustion until it is delivered into the furnace, and as all the air is always under control, any flame condition needed can be secured. The coal is burned under minimum velocity insuring clean working chambers and practically 100 per cent B.t.u. efficiency.

*Abstract of paper read at Fuel Economy Symposium held in connection with National Exposition of Chemical Industries.

Elisha S. Williams

THE death of Elisha S. Williams, vice-president of the United States Rubber Co., on Oct. 8, 1920, was a great shock and profound sorrow to the host of friends both in and out of the organization, who knew and loved Mr. Williams.

Mr. Williams possessed qualities of heart and mind which endeared him to a wide circle of friends and acquaintances. Courteous, considerate of others, kindly, with always the best interests of his associates at heart, he won the liking and good will of all with whom he came in contact.

Mr. Williams was born in Malden, Mass., in 1873, and was educated in the Malden public schools, taking a business course in the Malden high school. He then entered the employ of the Revere Rubber Co., and in the course of a few years became the New England manager, a little later the Chicago manager, and in a year or two was promoted to the position of general sales agent, which, in turn, led to his assuming the chief executive position in that company as treasurer, and later president.

Jan. 1, 1910, the Revere Rubber Co. was purchased by the United States Rubber Co. chiefly because of its desire to secure the services of Mr. Williams, who was then elected president of the Rubber Goods Manufacturing Co., which at that time through its subsidiaries controlled all the mechanical and tire business of the United States Rubber System. Mr. Williams was largely instrumental in the consolidation of the tire business of the company's subsidiaries by forming the United States Tire Co. in 1911, of which he was the president until 1915. In 1915 he was elected vice president of the United States Rubber Co., in charge of the mechanical goods business. He was also a director of the United States Rubber Co., a member of the operating council, and president of several subsidiary companies.

Red Cross Is Service

THE FOURTH Red Cross Roll Call is not a drive. It is not a campaign.

It is not an effort to raise any specific sum.

The $1 dues of 10,000,000 people for 1921 are payable and this Roll Call is merely the organized activity of collection.

The American Red Cross, by its Congressional Charter, is officially designated for the following purposes:

"To furnish volunteer aid to the sick and wounded in time of war, in accordance with the treaty of Geneva;

"To act in matters of volunteer relief and as a medium of communication between the American people and their Army and Navy;

"To continue and carry on a system of national and international relief in time of peace and to apply the same in mitigating the sufferings caused by pestilence, famine, fire, floods and other great national calamities and to devise and carry on measures for preventing the same."—Act of Congress, Jan. 5, 1905.

ANSWER THE RED CROSS ROLL CALL, Nov. 11, Armistice Day, to Nov. 25—Thanksgiving.

News Notes

FEDERAL POWER COMMISSION is now working on the remainder of the regulations to be issued under the Water Power Act, since they will shortly be required by applicants. An assistant counselor has been assigned to the local staff of the Commission by the Secretary of the Interior. A chief accountant will shortly be chosen and an accounting system devised to meet all of the requirements of the Commission in its handling of applications, preliminary permits, licenses, valuation work, and in its relationship to the states. Estimates for the financial requirements of the Commission for the coming year have been prepared and will be issued as soon as officially submitted.

A SITE FOR the new building in Washington which is to serve as a home for the National Academy of Sciences and the National Research Council has recently been obtained. It comprises the entire block bounded by B and C Streets and Twenty-first and Twenty-second Streets, Northwest, and faces the Lincoln Memorial in Potomac Park. The Academy and Council have been enabled to secure this admirable site, costing about $200,000 through the generosity of friends and supporters.

THE INTERSTATE COMMERCE COMMISSION has suspended the privilege of assigned cars to public utilities and will issue special permits to care for this class of consumer in the future. Another order gives absolute priority on all open-top cars for use in the transportation of coal. This is aimed to give minimum weekly production of 12,000,000 tons and meet the program to care for the Northwest by way of the Lakes.

AN INTERNATIONAL conference of delegates from important scientific academies to consider the future of the International Catalog of Scientific Literature has just been held in London at the invitation of the Royal Society. Representatives were present from 14 countries. The American delegates were Dr. R. M. Yerkes, Professor L. E. Dickson, Professor L. P. Eisenhart, G. C. Gunnell, and Dr. S. I. Franz, representing the National Academy of Sciences, the National Research Council, and the Smithsonian Institution.

Up to the time of the war, more than 30 countries were joined in undertaking the indexing and publishing the index of the scientific literature of the world; 14 annual issues, each of 17 volumes, have been published covering the literature from 1901 to 1914. The results of the war together with the much increased cost of printing and publishing have interrupted the undertaking and no index of scientific literature published since 1914 has been issued. The conference decided that even though a change may be made in the future in the method of indexing and of publishing the index, as has often been suggested, it is imperatively necessary to continue the present method until the scientific literature published up to the end of 1915 and possibly also that up to the end of 1920 has been catalogued.

THE BARBER-GREENE CO. has recently added L. M. Dozier to its force of salesmen in St. Louis. Mr. Dozier was formerly with the Lakewood Engineering Co.

U. S. CIVIL SERVICE COMMISSION announces an examination (receipt of applications to close Dec. 7, 1920) for junior mechanical engineer to fill a vacancy in the Engineering Department at Large of the War Department, for duty at Memphis, Tenn., at $2100 to $2400 a year, and vacancies in positions requiring similar qualifications throughout the United States, at these or higher or lower salaries. After 6 mo. satisfactory service, ap-

pointees may be allowed the increase granted by Congress of $20 a month. Competitors will be rated on education, preliminary experience, responsible experience and fitness. They must have had 4 yr. of preliminary practical experience in mechanical engineering work, either as workmen or draftsmen, or both, and at least 2 yr. of responsible drafting-room experience along machinery lines. The completion of each year of an engineering course in a college or university of recognized standing will be accepted in lieu of one year of preliminary experience. Apply for Form 1312, stating the title of the examination desired.

THE WESTINGHOUSE ELECTRIC & MANUFACTURING Co. has added a new foundry building, 120 by 200 ft., to its South Philadelphia Works. The architecture of the building is of "daylight" design with the skylight glass beginning about 3 ft. 7 in. from the ground and extending over the entire building, which at the highest point is about 26 ft. This foundry will be used to make castings that weigh a half pound upward to one-half ton.

AN INTERESTING detail of the change in name of the American Steam Conveyor Corporation to that of "Conveyors Corporation of America" is an addition to the personnel of the Eastern sales organization. Clarence C. Brinley has been retained as Eastern manager of the Trolley Carrier Department, and will be attached to the New York office, 110 W. 40th St. Mr. Brinley is an engineer of broad experience in elevating and conveying machinery and has a wide acquaintance in engineering and business circles in the East.

AT A RECENT MEETING of the Board of Directors, J. J. Arnsfield, advertising manager of Fairbanks, Morse & Co., was elected president of the Engineering Advertisers' Association of Chicago to fill the vacancy made by the resignation of A. H. Hopkins, who severed his connection with the C. F. Pease Co. to take charge of the domestic advertising division of the J. Roland Kay Co. Keith J. Evans, advertising manager of Jos. T. Ryerson & Son, was elected vice-president, and Julius Holl, advertising manager of Link-Belt Co., was elected to the board of directors to fill the vacancy made by Mr. Hopkins' retirement.

Trade News

COMBUSTION ENGINEERING CORPORATION, 11 Broadway, New York City, has acquired control of the business of the Pulverized Fuel Equipment Corporation, known as Lopulco Systems. With Lopulco Systems, are taken over the entire organization of the Pulverized Fuel Equipment Corporation, including V. Z. Caracristi as consulting engineer, thus giving the engineering public the combined brains, experience, and ability of the engineers of both corporations on any combustion engineering problem that may be presented.

THE VIRGINIA ICE AND FREEZING CORP., of Norfolk, Va., is to install three 300-hp. type "E" Smith gas producers, manufactured by the Smith Gas Engineering Co. of Dayton and Lexington, Ohio. The producers will be used to supply gas for engines and will supplement two 300-hp. producers of the same make which met the power requirements before expansion became necessary.

This producer plant is designed for anthracite coals and is giving excellent satisfaction. Producers are provided with air operated shaking grates and special cleaning or scrubbing equipment of the baffle type.

WE HAVE recently received an announcement of the formation of the C. W. Hunt Engineering Corporation, with offices at 143 Liberty St., New York City, for the purpose of handling all sales entailing engineering in connection with the Hunt products and all engineering services previously performed by C. W. Hunt Co., Inc.

REGO Welding and Cutting Apparatus Catalog No. 20 illustrates the various apparatus and tests for flashbacks, describing details of torches and regulators. The manufacturer is The Bastian-Blessing Co., Chicago.

THE ENGINEER Co., 17 Battery Pl., New York City, has issued a new book, "Modern Practice in Combustion Control." This book is a readable book on an important and timely subject, treating the matter in a common sense, practical way. A copy may be obtained by writing to the Engineer Co. at the address given.

THE WESTINGHOUSE Electric & Manufacturing Co., East Pittsburgh, has issued Leaflet No. 3461 which describes and illustrates its automatic current regulator for electric arc furnaces with movable electrodes. Schematic wiring diagrams and photographs of detailed parts of this apparatus are produced.

THE LINK-BELT Co., 910 S. Michigan Ave., Chicago, recently published an attractive 24-page illustrated book covering its traveling water screens, demonstrating that surface condensers being easily clogged by trash contained in the water supply, and hard to clean, clogged condenser tubes mean reduced efficiency of operation and other disadvantages.

This publication will be sent to anyone interested in the effective and economical screening of condensing water.

HARRIS BROTHERS Co., of Chicago, is issuing a catalog of structural steel which shows the kind of structures the company has been erecting for factories, warehouses and power plants. It covers a great variety of buildings and will be found of interest to those who have in mind the erection of any kind of steel frame buildings.

A special boiler bulletin, No. 8G504, gives specifications and details of a water tube boiler which Harris Brothers Co. has for sale, purchased from the United States Shipping Board. These are three and four pass boilers, some with superheaters and all with sheet steel enclosure.

THE ILLINOIS STOKER Co. has just issued a catalog on its natural and forced draft chain grate stokers. In the preface, hand firing vs. stoker firing, mechanical chain grate stokers, and air control are treated in a concise general way to prepare the reader for the detailed descriptions of the stokers including their special mechanical and constructional features, merits and advantages, which occupies the great share of the book. The last pages are devoted to a discussion of boiler and furnace efficiency and a number of graphic calculating charts which are of aid in working up test and operating data.